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BACK UP CLUSTER HEAD DETERMINATION IN WIRELESS SENSOR ROUTING USING SUPERVISORY SELECTION TIME APPROACH

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In Wireless Sensor Network, dynamic cluster based routing protocol approach is mostly used. In this approach, most frequently cluster reelection algorithm is performed due to the energy depletion of cluster heads. This repeated cluster head reelection increases the number of advertisement messages which in turn depletes the energy of overall sensor network. Here, we proposed a novel Supervisory Selection Time Approach (SSTA) that reduces the cluster set up communication overhead in backup node determination Phase. This is achieved by sending the Single Multipurpose Advertisement Message which has the capability to learn available alternative paths from sensor nodes to sink and also reelect the back up cluster heads in well advance. This makes our routing protocol more energy efficient, fault tolerant and load balanced. Our protocol implementation shows that our approach is better than LEACH and also significantly reduces the total number of setup messages and also increases the data delivery.

Keyword: Cluster based Routing, Wireless Sensor Network Improving Data Delivery, SSTA.

1. Introduction

Wireless Sensor Networks (WSNs) are formed by a set of nodes that gather information and forward it to a sink. They are formed by small, inexpensive and resource limited devices that can interact with the environment and communicate in a wireless manner with other devices [1] WSNs present a new challenge research problem due to their high flexibility to support several real-world applications. The core operation of wireless sensor network is to collect and process data at the network nodes, and transmit the necessary data to the base station for further analysis and processing. Due to large network size, limited power supply, and inaccessible remote environment, the WSN-based protocols are different from the traditional wireless protocols [2].Currently there are several energy efficient communication models and protocols that are designed for specific applications and topologies.

LEACH (Low Energy Adaptive Clustering Hierarchy) is one of the most referenced protocols in the sensor networks area [3],[4],[5]. In LEACH and other routing protocols, when current cluster head changes due to self destruction or energy loss, increases the overhead, in turn leading to higher energy consumption. This is one of the worrying drawbacks. A possible solution which is proposed in this paper is the use of the Supervisor Selection Time to reduce set-up communication overhead. During this Supervisory time, sensor nodes receive advertisement messages and from this, node determines multi-route for transmission and consider only the message with the minimum number of hops and back up cluster heads are elected.

The rest of the paper is organized as follows. Section II reviews the related work. Section III describes the proposed method of SSTA for cluster formation. Section IV Presents Simulation results.Section V Concludes the paper.

2. Literature Survey

Hierarchical or Cluster based routing, originally proposed in wire line networks, are well-known techniques with special advantages related to scalability and efficient communication. As such, the concept of hierarchical routing is also utilized to perform energy efficient routing in WSNs. In a hierarchical architecture, higher nodes can be used to process and send the information while low energy nodes can be used to perform the sensing in the proximity of the target. This means that creation of Clusters and assigning special tasks to cluster-heads can greatly contribute to overall system scalability, lifetime, and energy efficiency.

Hierarchical routing is an efficient way to lower energy consumption within a cluster and by performing data aggregation and fusion in order to decrease the number of transmitted messages to the base station.

Heinzelman[4] introduced a hierarchical clustering algorithm for sensor networks, called Low Energy Adaptive Clustering Hierarchy(LEACH). LEACH is a cluster based protocol, which includes distributed cluster formation. The operation of LEACH is split into two phases, the set-up phase

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and steady state phase. During the set-up phase, the clusters are created and cluster heads are elected. LEACH randomly selects a few sensor nodes as cluster-heads and broadcast an advertisement message to the entire network declaring that they are the new cluster heads. Every node receiving the advertisement decides to which cluster they wish to belong based on the signal strength of the received message. The sensor node sends a message to register with the cluster-head of their choice. Based on a TDMA approach, the cluster head assigns the time slot to registered node for sending the data.

During the steady-state phase, sensor nodes can start transmitting data to their respective cluster-head. The cluster head applies aggregation functions to compress the data before transmission to the sink. After a predetermined period of time spent on the steady-state phase, the network enters the set-up phase again and starts a new round of creating clusters.

Although LEACH is able to increase the network lifetime, there are still a number of issues about the assumptions used in this protocol. LEACH assumes that all nodes can transmit with enough power to reach the base station if needed and that each node has computational power to support different MAC protocols. Therefore, it is not applicable to networks deployed in larger regions. It also assumes that nodes always have data to send, and nodes located close to each other have correlated data. It is not obvious how the number of the predetermined cluster-head is going to be uniformly distributed through the network. Therefore, there is the possibility that the elected cluster head will be concentrated in one part of the network. Hence, some nodes will not have any cluster heads in their area.

Lindsey and Raghavendra[6].[7] proposed an enhancement over LEACH protocol. The protocol, called Power-Efficient Gathering in Sensor Information Systems (PEGASIS), is a near optimal chain based protocol. It achieved the performance through the elimination of the overhead caused by dynamic cluster formation and through decreasing the number of transmissions and reception by using data aggregation. Although the clustering overhead is avoided, still requires dynamic topology adjustments.

This paper provides a protocol with the same underlying benefits as LEACH and PEGASIS and reduces the number of set-up messages required which in turn increases the network lifetime.

3. PROPOSED APPROACH

3.1. Supervisory Selection Time Approach (SSTA) Routing Protocol

In this paper, we present a SSTA Routing protocol for cluster formation in Wireless Sensor Networks. The main objective of this approach is to minimize the set-up communication overhead, whenever current cluster head changes. These changes are due to cluster head failures or when its energy level approaches a certain threshold value. During the Supervisory Selection time, sensor node receives single multi-purpose message and from this the node starts to determine the following 1) possible routes from the cluster head to sensor node 2) learns the minimum number of hops to reach the selected cluster head.3) Backup nodes are chosen for next to current cluster head. Hence, this single multi-purpose advertisement message can be used for both reducing the set-up communication overhead and fault tolerant, thus makes our protocol more energy efficient.

The operation of the proposed routing protocol can be split into two phases: the Backup node determination phase and the data transfer phase.

A. Backup Node Determination Phase: During this phase, cluster heads are selected and clusters are formed. At the start up, base station randomly selects some desired percentage of nodes as cluster heads and broadcasts selected information to the network. On receiving the broadcasted information, each node checks its status whether it has been selected as cluster head or not. If yes, it starts a new cluster formation by broadcasting an advertisement message. Otherwise, it forwards the message to its neighbors. Every cluster head creates an advertisement message which has the number of hops count to zero and broadcast it to its neighbors. If a node already belongs to another cluster for which the number of hops to reach the current belonging cluster is less than newly received broad cast then it ignores the received message.

The Supervisory Selection Time of a node starts when it accepts an advertisement message. When the Supervisory Selection time is still valid, the node caches the received message and waits for other possible advertisement. In this way, it collects all possible alternative paths to chosen cluster head. All the sensor nodes consider the message with minimum number of hops count (shortest route) as the best route. When route fails, an alternate route can be immediately used without delays or degradation of QoS.When the Supervisory Selection Time reaches zero, a route is established with shortest route and increases the number of hops count by one in the retained message and broadcasts it to its nearby nodes.

After Supervisory Selection Time expires, all sensor nodes who receive the advertisements message are candidate for stand by node to their respective cluster head. Each candidate sensor nodes calculates its available energy before sending its registration for acting as backup node to their cluster heads. All currently acting cluster heads adds its corresponding stand by nodes registration request to its cluster head backup list.

When the cluster round time is over or energy level approaches a threshold, the current cluster head hands the main role to the first node in the backup node list. With a single flooding to cluster members, the new cluster head continues its main role without the need for further communication.

B. Data Transfer Phase: The second phase is called data transfer or steady state phase. This phase is identical to steady state phase proposed in LEACH[8].The steady state is broken into frames where nodes send their data to the cluster-head at most once per frame during their allocated transmission slot which scheduled by TDMA. Once the cluster- head receives all the data, it performs data aggregation and forwards the final data to the base station.

4. SIMULATION

For our SSTA approach simulation, we gave all the nodes an initial supply of energy and ran the protocol until it is united. As we mentioned, energy efficiency of our approach is measured in terms of number of advertisements in the role determination phase. For our experiments, we created 50 nodes network where the nodes are scattered in 500x500 grid and Fig.1 and Fig.2 respectively shows the Geographical cluster formation of 50 nodes using LEACH and SSTA Approach.

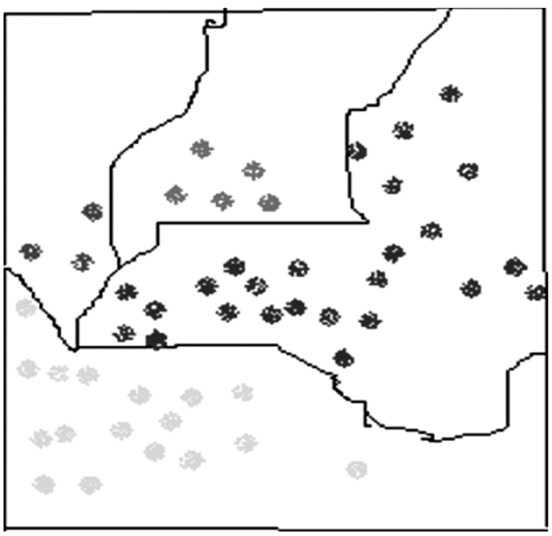

Fig.1: LEACH Cluster Formation

Our simulation runs on 50 nodes and we choosen the number of cluster as 4.As shown in fig.3. For the LEACH approach, Cluster 1 and cluster 3 holds 50% and 34% of the network population respectively. Cluster 2 and 4 holds 10% and 6% of the network population respectively. It shows that there is no uniform distribution of sensor node numbers among the clusters. Due to this type of poor distribution of nodes among clusters, here Cluster 1 and Cluster 3 head undergoes quick energy depletion.

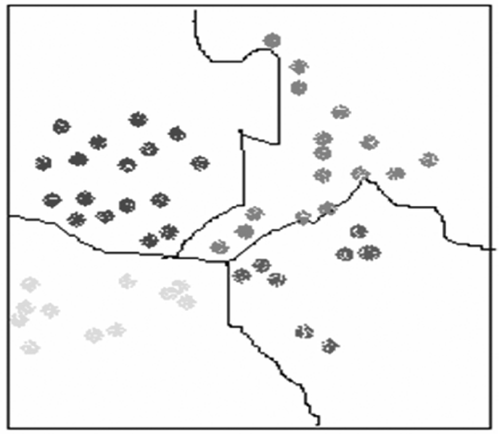

Fig.2: SSTA Cluster Formation

This in turn increases the number of advertisement messages as a result of frequent cluster head reelections. In the case of our SSTA, cluster 1, cluster 2, cluster 3 and cluster 4 holds the 32%, 30%, 22% and 16% of the network population respectively. This kind of uniform distribution is achieved due to the usage number of hop metric as part of advertisement message in the role determination stage.

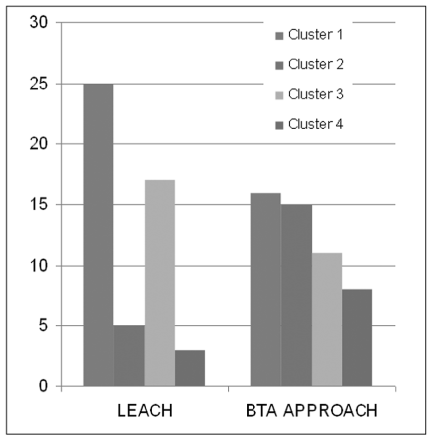

Fig. 3: Nodes Distribution in LEACH and SSTA Approach

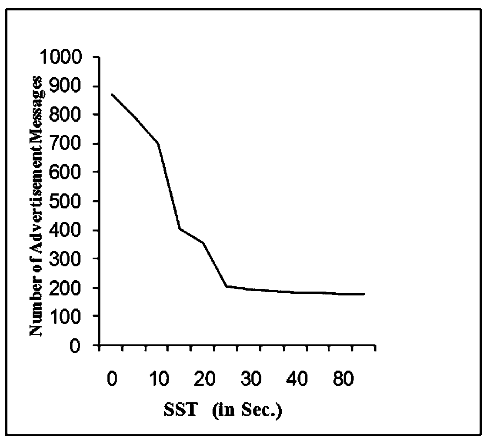

Fig. 4: Number of Advertisement Message Vs SST (in Sec)

The fig.4 shows the graph between Variable Supervisory Selection Time and Number of Advertisement message. It depicts that number of advertisement message in SSTA is same as LEACH when Supervisory Selection Time is 0. As Supervisory Selection Time increases the number of advertisement message is reduced. This is because all sensor nodes get enough time to receive advertisement from all cluster heads.

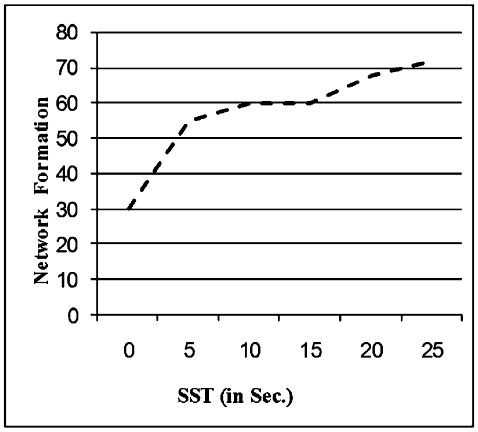

Fig.5: Supervisory Selection Time (sec) Vs Network Formation (sec)

The fig.5 shows the graph between network formation time and varying Supervisor Selection Time. As our result shows that network formation time is increasing proportionally as Supervisor Selection Time increases. This means, reducing the Supervisor Selection Time to a minimal value to achieve improved efficiency.

5. CONCLUSION

In this paper, we proposed a SSTA routing protocol which is successful in decreasing the number of advertisement message and also finds all possible alternate paths to sink node. This is achieved with the help of multipurpose advertisement message. This makes our protocol more energy efficient and also not prone to failures. In future, we would like to modify our protocol such that cluster formation is done through Bio inspired approach.

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