"Scalability of the Wireless Sensor Networks on Hierarchical Routing"

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Abstract: A wireless sensor network is the network consisting of numerous small sensor nodes with sensing, processing and wireless communication capabilities. Many routing protocols are suggested for wireless sensor networks due to the several limited resources of a sensor node such as its limited CPU, memory size, and battery. They can be divided into flat and hierarchical routing protocols. The hierarchical routing protocol uses the clustering scheme and shows better performance than flat routing protocols. However, there is an assumption that sensor nodes can communicate with the base station by a one-hop routing in the hierarchical routing protocol. However, if the network size become larger, the hierarchical routing protocol is unsuitable because a long distance between a clusterhead and the base station can cause some communication problems. In this paper, we propose the clusterhead chaining scheme to solve this problem. Our scheme is suitable for vast wireless sensor networks and it was found from the simulation result that the proposed scheme shows better performance than the general hierarchical routing protocol.

KEYWORDS*: Clusterhead Chaining; LEACH Protocol; Secondary Clusterhead*

I. INTRODUCTION

A wireless sensor network is consists of many small sensor nodes with sensing, processing and wireless communication capabilities. Many routing protocols are proposed for wireless sensor networks because the sensor nodes have limited resources such as its limited CPU, memory and battery. The proposed routing protocols can be divided into flat and hierarchical routing protocols.In flat routing protocols, a data aggregation process is essential to reduce its energy consumption which results from the duplicate transmission of similar information among the adjacent nodes. The hierarchical routing protocols are proposed to solve this problem. It divides sensor network into several clusters and clusterheads are selected in the every cluster. The clusterhead is responsible for better performance than flat routing protocols on the energy consumption. Clusterhead can communicate with the base station which is located outside of the wireless sensor networks by a one-hop routing. If the network size become larger, this protocol is unsuitable for the vast sensor networks because of a long distance can cause serious communication problem. Therefore, considering restricted resources of the sensor node, this assumption is inappropriate for application is massive sensor networks. The LEACH (low energy adaptive clustering hierarchy) routing protocol is a representative hierarchical routing protocol. It also has this assumption. We proposed the clusterhead chaining scheme to overcome this problem and this scheme shows better performance than the LEACH routing protocols.

II. EXISTING SYSTEM

The hierarchical routing protocols are proposed to solve this problem. It divides sensor network into several clusters and cluster heads are selected in the every cluster. The cluster head is responsible for the gathering and aggregation of the information in its cluster In general, they have better performance than flat routing protocols on the energy consumption. However, the hierarchical routing protocol has an assumption that a cluster head can communicate with the base station which is located outside of the wireless sensor networks by a one-hap routing. Especially, if the network size become larger, this protocol is unsuitable for the vast sensor networks because of a long distance can cause serious communication problems.

III. PROPOSED SCHEME.

The proposed scheme consists of four phases which are the clusterhead selection, cluster formation, clusterhead chaining, and data transmission. This proposed scheme is based on the LEACH routing protocol and trying to improve it by using the clusterhead chaining scheme. The performance of LEACH protocol is improved here. The energy consumption of sensor nodes which is located in near the base station becomes larger because their size of data transmission from them to the base station becomes bigger than the other nodes. Therefore, the LEACH routing protocol uses a clustering scheme in order to distribute the energy consumption evenly and to maximize the survival time of sensor nodes in wireless sensor networks[3]. Several clusterheads are selected and clusters are formed with a clusterhead as the center. All nodes perform on the role of a clusterhead in turns. Therefore, they can cost the energy evenly. The four phases are

- **Clusterhead selection**

At this Phase base station sends threshold signal to the network. In the network sensor nodes communicates with each other and it calculates the number of nodes one particular node communicates. If it is greater than or equal to the threshold it is selected as the clusterhead or else it is a normal sensor node

- **Cluster formation**

The node reports that they are member of the cluster to its clusterhead by analyzing the distance between this node and the clusterhead.

- **Clusterhead chaining**

At this phase, every clusterhead realizes neighbouring clusterheads. All clusterheads are formed a chain by using a chaining scheme. The clusterhead can always send its data only to neighbouring clusterhead, even though the size of a sensor network becomes a very larger. If any clusterhead gets failed it makes use of secondary clusterhead to form chain.

- **Data transmission.**

Each sensor node sends a message by its TDMA schedule. Then a clusterhead receives the information of all nodes and performs a data aggregation. After that, a clusterhead sends a processed data to a neighbouring clusterhead.

3.1 Methodology

3.1.1 Clusterhead selection phase

At this phase, clusterheads are selected [8]. Each sensor node selects random number from 0 to 1. If the random number is smaller than a threshold, the sensor node is selected as a clusterhead. As shown in Fig. 4,

the clusterheads notice that they are selected as a clusterhead to neighbouring nodes. The nodes which are received this message compare the strength of the signal from clusterheads and choose the clusterhead which sends the strongest signal as its clusterhead. Two clusterheads are selected per cluster. Because in case any clusterhead gets failed it can make use of the second one The size of the cluster is an important parameter. If the cluster size is decreased, the power consumption within each cluster is smaller. Yet the number of CHs will then be increased, so that the resulting backbone network formed by these CHs will become more complicated. A smaller number of CHs will form a simpler backbone network. Yet that would require larger cluster size, so that the RF power in each cluster becomes higher. There is then a trade-off between the cluster size and the number of CHs. Currently, most clustering protocols assume the network is organized into clusters of equal size, but such clustering results in an unequal load on the cluster head nodes. In multi-hop WSNs, when CHs cooperate with each other to forward their data to the BS, the CHs closer to the BS are burdened with heavy relay traffic and tend to die early, leaving areas of the network uncovered and causing network partition.

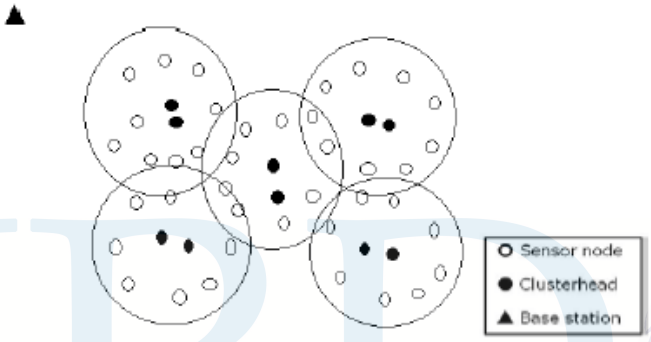

Fig 4: Clusters Heads

3.1.2 Cluster Formation Phase

The node reports that they are member of the cluster to its clusterhead. After that, the clusters are formed. Also, clusterheads and the member of clusters are fixed as shown Fig. 5.

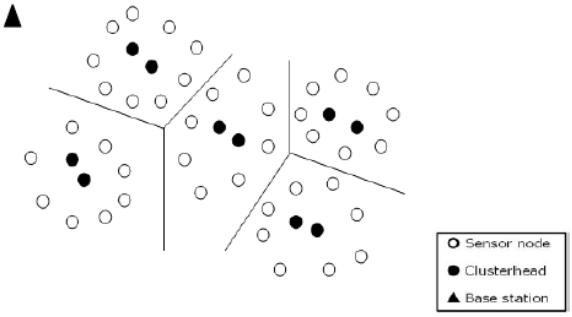

Fig 5: Formation of Clusters

3.1.3 Clusterhead Chaining Phase

At this phase, every clusterhead realizes neighbouring clusterheads. A clusterhead in a cluster involves in the formation of chain using chaining technique. If any clusterhead gets failed it makes use of secondary clusterhead which is present in the cluster as shown in the Fig.6.Secondary clusterhead also involved in large number of communications with the sensor nodes. The clusterhead can always send its data only to neighbouring clusterhead, even though the size of a sensor network becomes a very larger.

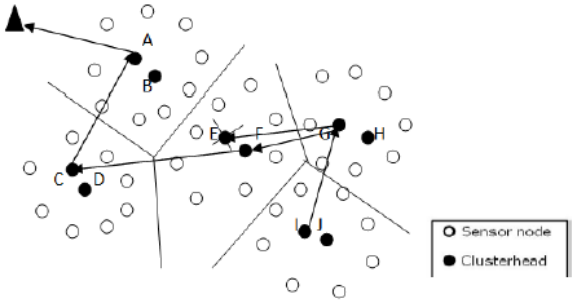

Fig 6 : Chain of Clusters

3.1.4 Data Transmission Phase

As shown in Fig. 7, each sensor node sends a message by its TDMA schedule. Then a clusterhead receives the information of all nodes and performs a data aggregation. After that, a clusterhead sends a processed data to a neighbouring clusterhead.

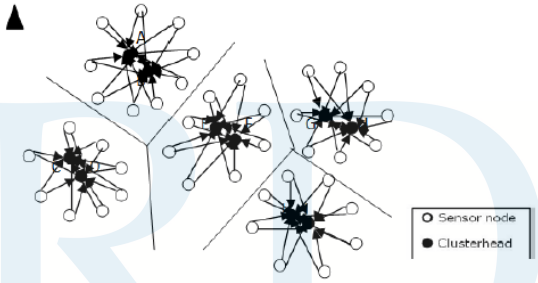

Fig 7: Delivery of Data to cluster Heads

As shown figure 8, each clusterhead transmits its data not to the base station but to the closest neighbouring clusterhead. Therefore, this scheme brings us the scalability of a sensor networks. After all clusterheads perform the process of the chain construction, each clusterhead delivers its sensing data to its neighboring clusterhead. Then the neighbouring clusterhead aggregates them with its data and transmits these data to its neighbouring clusterhead. Finally, the nearest clusterhead from the base station sends whole data to the base station.

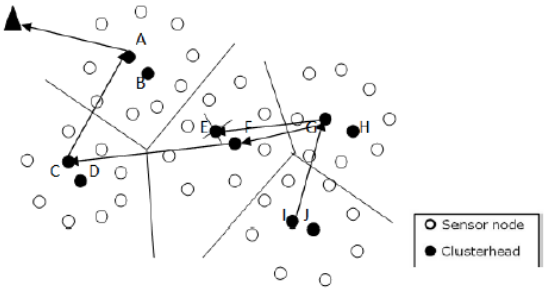

Fig 8 : Delivery of Data to Neighboring Clusterhead

As mentioned above, sensor nodes have several limited resources such as a CPU, memory, and battery. So, if the distance between the base station and clusterhead is too far, then a clusterhead may not communicate with the base station. Therefore if the network size becomes larger, to apply the existing routing protocols which use clustering scheme may cause a communication problem. In this paper, we proposed improved scheme by using a clusterhead chaining. It is adaptable to vast wireless sensor networks and energy efficient.

IV. SYSTEM REQUIREMENTS

4.1 HARDWARE REQUIREMENTS:

1 10GB HDD(min)

2 1GB RAM(min)

3 Pentium P4 Processor(min)

4.2 SOFTWARE REQUIREMENTS:

1 Operating system: Window XP Professional higher

2 Front End :Microsoft Visual 2010

3 Language : C#

V. System Architecture

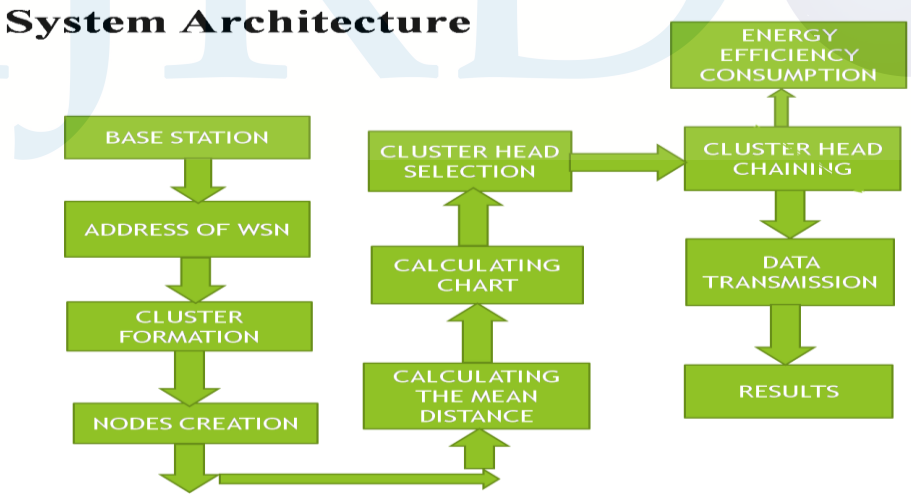

Fig 9: system architecture

5.2 Sequence Diagram

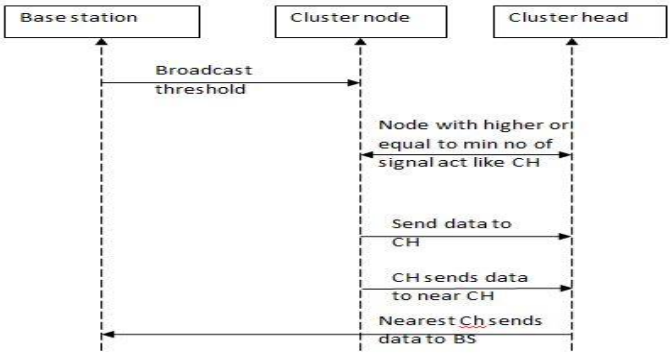

Fig 10: Sequence diagram

VI. SNAPSHOTS

6.1 Selecting the clusterhead

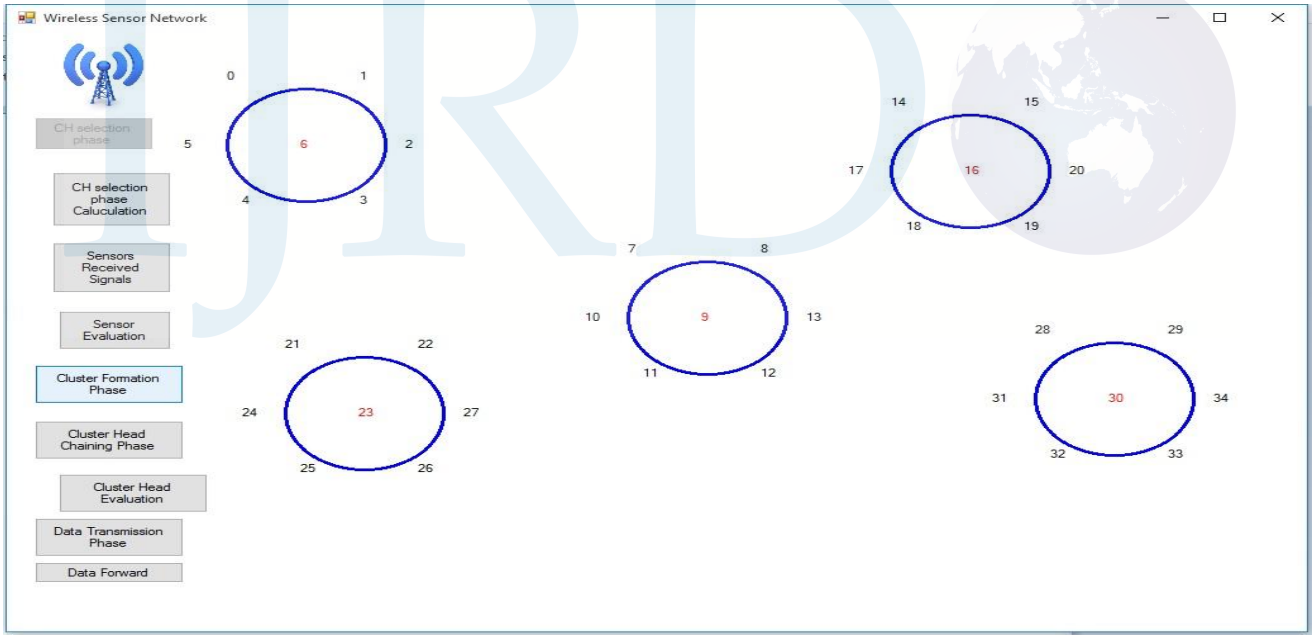

Fig 12: selecting the clusterhead

At this phase, clusterheads are selected [8]. Each sensor node selects random number from 0 to 1. If the random number is smaller than a threshold, the sensor node is selected as a clusterhead. As shown in Fig. 4, the clusterheads notice that they are selected as a clusterhead to neighbouring nodes. The nodes which are received this message compare the strength of the signal from clusterheads and choose the clusterhead which sends the strongest signal as its clusterhead.

6.2 Data Transmission between clusterhead and sensor node

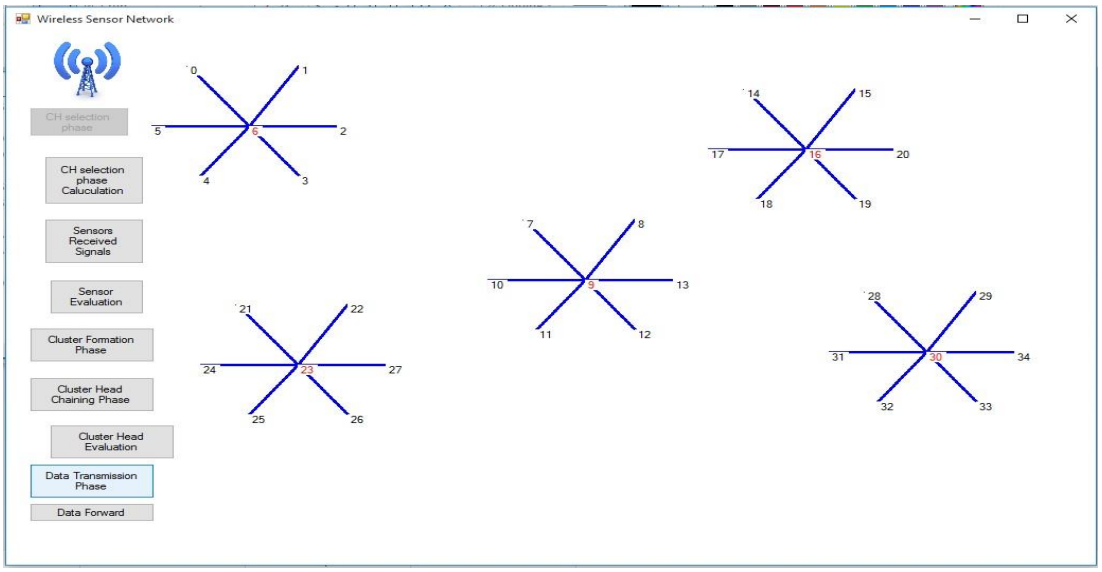

Fig 13: Data Transmission between clusterhead and sensor node

As shown in Fig. 13, each sensor node sends a message by its TDMA schedule. Then a clusterhead receives the information of all nodes and performs a data aggregation. After that, a clusterhead sends a processed data to a neighbouring clusterhead. each clusterhead transmits its data not to the base station but to the closest neighbouring clusterhead. Therefore, this scheme brings us the scalability of a sensor networks. After all clusterheads perform the process of the chain construction, each clusterhead delivers its sensing data to its neighboring clusterhead. Then the neighbouring clusterhead aggregates them with its data and transmits these data to its neighbouring clusterhead. Finally, the nearest clusterhead from the base station sends whole data to the base station.

VII. CONCLUSION AND FUTURE ENHANCEMENT

In the hierarchical routing protocol, a sensor network is divided into several clusters and clusterheads are selected in each cluster. The clusterheads are responsible to gather and aggregate the data of its cluster. The clusterhead has to send the aggregation data to the base station. The hierarchical routing protocol is energy efficient because all sensor nodes take the role of a clusterhead in turns. However, most of the hierarchical routing protocols have the assumption that all sensor nodes can transmit the data to the base station by one-hop routing. Therefore, if the network size becomes larger, serious communication problems may occur. If the distance between a clusterhead and the base station is too long, then the clusterhead cannot communicate with the base station and its data can be missing.

We proposed the enhanced scheme which is used the clusterhead chaining to solve this problem. The clusterheads only send its collected data not to the base station but to the neighboring clusterhead without the

last sensor node in the chain. This scheme is suitable for the massive sensor networksand also energy efficient. In the future, we wish to evaluate the
performance to the various environments. Also, we wish to expand this study to the mobile clouds.

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