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Energy Efficient Cluster Based Routing Protocol for Dynamic and Static Nodes in Wireless Sensor Network

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Abstract

Power consumption is considered one of the most significant challenges in the wireless network sensors (WSNs). In this paper, an investigation of the power consumption is done by making a comparison between static and dynamic WSNs. We have compared the results of the static network with the results of the dynamic network. Static and dynamic wireless Sensor networks have the same architecture (Homogenous) and proposed protocol. Depending on the suggested protocol, the simulation results show that the energy consumption in the static wireless sensor network was less than the dynamic wireless sensor network. However, moving the sensors in the dynamic WSN present real improvement in delivering packets to the base station. In the proposed routing protocol, transmitting data process is done in a hierarchal way. Cheap sensors are introduced and deploy them intensively to improve the QoS in the network. The final results and the conclusion are reported.

Keywords*: wireless sensor network, static and dynamic, efficient routing protocol, power consumption, delivering packets*

1. Introduction

Wireless Sensor Networks (WSNs) have locative distributed independent sensor nodes to sense a lot of environment situation. Typically, these sensors consist of Micro-electronic system, a low-power Digital Signal Processing (DSP) [1]. WSNs can be a mobile station (MS) to be capable of interacting and detecting efficiently with the environment same case in robotic networks or any sensor network [2]. WSNs have broad applications in various areas. From these applications as examples are, sound, vibration, pressure, motion or pollutants, surveillance for safety and security, automated healthcare, intelligent building control, traffic control, as much as in the reliable environment monitoring in military applications [3-4].

Each sensor can communicate with another sensor or directly with base-station (BS) [5-6]. They are scattered in a sensor field, which is an area where the sensor nodes are deployed. They organize among themselves to get high-quality information about the physical environment [7-8]. To boost the number of sensors as much as possible for covering a broader geographical area region and with higher accuracy. In spite of these sensors are not accurate as their expensive macro-sensor counterparts, but they enable applications to networks [9].

The main critical issue in sensor networks is the limited energy on network nodes [10]. Once they are distributed, the network can keep running on while the energy of nodes is sufficient. The main point is almost impossible to replace the battery of each node in inaccessible areas [11-12]. This shared wireless network configured by WSN, the individual nodes have a limited communication range medium [13]. Both the data and control packets need to be routed in multi-hop modality [14].

The data can be shown between the nodes in the network to support different activities. The above-mentioned complex task is obtained by designing and implementing routing schemes that can efficaciously support the interchange of information in wireless sensor networks [15]. Many practical case and theoretical restrictions should be totally taken into account. In general, wireless sensor information can be fed throughout a couple means. The particular past post information to the basic section immediately regarding additional running. This latter post information through forwarding to various other nodes just before reaching the

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base section. Every single process offers its worth for the applications as well as routing standards. Through the standpoint involving circle topology, this routing standard can be categorized straight into common topology as well as cluster topology [16]. A number of routing standards throughout clustered (WSNs) are usually described within the subsequent [17].

Clustered (WSNs) are commonly labelled as heterogeneous as well as good homogeneous capabilities for operations involving sensor nodes [18]. Throughout (WSNs) with heterogeneous sensor equipment, this cluster mind offers superior apparatus compared to a standard sensor node, e.g. power, processing capability, memory, and in many cases with any performance involving information compression setting [19]. In homogeneous networks, energy and hardware complexity are identical for all sensor nodes. However, all sensor nodes inhomogeneous networks will lose energy at about the same time which means the network will shut down at one time [20]. In fact, each sensor node can to be a cluster head, but it does not indicate when the failure of a few nodes the network will run down [19]. The particular essential function of any heterogeneous method would be to decrease the energy usage of standard nodes through protecting against all of them from sending data over a long distance of the basic section.

The routing protocols for (WSNs), comparison for their strengths and limitations are done by Shio Kumar Singh, et al. [21]. Back off-based clustering in (WSNs) and the comparison has done with flat routing protocols and the integrated multihop technique. Is a well-known hierarchical routing project employed throughout clustered (WSNs), because it can easily balance energy consumption to extend this circle lifespan [22]. It functionally consists of a couple of stages. In the setup stage, the sensed data are transferred from nodes to cluster heads, finally reaches the (BS). In the second section of the process which is longer, depends on the round-based clustering algorithm [23]. It's well known that LEACH uses the CDMA-TDMA hybrid communication scheme to minimize the interference between clusters. While TDMA slots are assigned for each member to minimize media contention [24].

LEACH is divided into rounds in to appoint cluster heads at the beginning of each round to create and broadcast schedule to its members. Neglecting the problem caused by the random head selection in each round [25]. A scheme is based on a new criterion to give the opportunity for sensor node to make a distributed decision on whether electing to be a cluster head or a non-head member. Also, a scheme is a fully distributed approach and proposed by LIANG ZHAO et al. [26]. This proposed model achieved better performance in the term of lifetime and energy ratio. Where the designed Medium-contention based Energy-efficient Distributed Clustering (MEDIC), to replace the cluster formation this takes place at the beginning of each round in LEACH. This designed (MEDIC) is based on the Duch auction to get higher time efficiency in the form of each node to count its neighbours and broadcasts their number [27].

Lately, quite a few reports were being focused on lowering the energy use of sensor nodes throughout (WSNs). This particular work aims to investigate the comparison between the static and dynamic model to increase the lifetime by decreasing the use of energy. Try to improve the lifetime of (WSNs) by using cluster blending as well as energetic routing components. A study to save energy during data transmission is done by Wernhuar Tarng et al. [28]. This study stated that the dynamic routing method inclueds two stages, initialization state and operating stage. During these two states and to save energy consumption data aggregation and sleep mode is used.

The current study depends on dividing the environment into smaller areas to distribute the sensor nodes, and each region has five sensor nodes distributed in a determined position by a pseudo random generator. Typically, these cluster-based routing components try to boost the time of (WSNs). For that understanding, conserving energy will be involving great importance inside a wide-range sensing atmosphere. A static clustering protocol configures the sensor node straight into quite a few groupings involving identical sizing. Normally, the cluster head of the basic section will take up extra energy through forwarding information regarding various other groupings. As this is an investigative paper, in the next section presents the paper related work. In section III describes the proposed work, Results presents in section IV, whereas, section V discussed the conclusion.

2. Related Works

Different methods being developed for reducing energy consumption in the technology of (WSNs). Fatma Bouabdallah et al. proposed the potential performance improvement gained by balancing the traffic throughout the (WSNs) [29]. They showed the traffic generated by each sensor through multiple routes, instead of a single one. Besides, Heinzelman et al. proposed a clustering protocol called LEACH for data gathering applications [30]. LEACH depends on the randomized rotation of cluster heads to distribute energy consumption over all nodes in the network. To optimize energy consumption through optimal clustering of sensor nodes. As alongside, Ghiasi et al., presented his work concentrating on the clustering problem in (WSNs) [31]. They proposed an algorithm so that the distance between sensor member nodes and CHs is minimized.

Low-energy adaptive bunch Hierarchy (LEACH) is meant for proactive sensing element networks; during which the nodes sporadically start their sensors and transmitters; the sensor senses the environment and transmits the information. More applicable for this environment is that the protocols used are unstructured distributed storage [32]. While A. Haider et al., proposed a model for (WSNs) to improve the lifetime of the network called regional energy efficient cluster heads (REECH) which is based on maximum energy (ME) [33]. In their model, the cluster head (CH) is selected according to its maximum energy in each round. This model uses the probabilistic approach to choose the (CH). As much as the proposed model implements the uniform random distribution model to find the packet drop to make it more practical.

3. LEACH Algorihim Explination

LEACH is standing for low-energy adaptive clustering hierarchy which is proposed to reduce the energy to increase the lifetime in the wireless sensor networks. It is one of the most important hierarchical routing protocol to choose the clusters in the network depending on the strength of the received signal as shown in the figure below. Based on the total number of the network, a limited percentage of the sensors are elected to be the cluster head. The cluster heads act as a new router for the base station (Sink). The power consumption for the network will be reduced as the transmission of the data done by the cluster head.

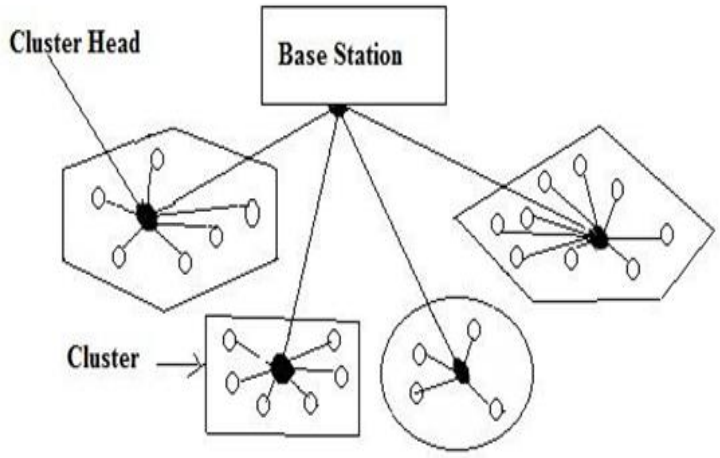

Figure 1. Cluster head of LEACH protocol in WSN

Aggregation and data fusion are inside the cluster. The cluster heads are changing randomly to equilibrium the energy waste of the nodes. Whether nodes number is less the following threshold, the node will act as the cluster head for the current ride. Also, a random number between 0 and 1 is picked to choose the node.

$$N(n) = \begin{cases} \dfrac{s}{1 - s * \left(r \bmod \frac{1}{s}\right)} & if\ n \in G \\ 0 & otherwise \end{cases} \quad (1)$$

Where S is the percentage of the desired cluster head, r is the current ride, and G is the group of nodes that are not chosen to be cluster head in the last 1/S ride, and N (n) is the threshold [34].

4. Proposed Work

In this part of the paper, we use a novel routing protocol for (WSN's). The wireless network is done with the following suggestions.

a. Nodes, which are used in WSN's system, are dynamic (mobility).
b. The base station which is used in the same WSN's system is static (no mobility).
c. Nodes cannot recognize their physical position by their own in the sensor domain.
d. The base station can define the WSN's topology in the running time.
e. Sink defines the proportional location of the nodes in the domain.
f. Any sensor can use power domination to modify the transferred power.
g. The wireless sensor network will be inefficient when (50%) of the gross sensors in the domain died.
h. The sensors are cheap and spread very intensely. This intense apportionment of the nodes will be useful to increase the quality of service (QoS) out of WSN's
i. The architecture of the sensors is homogenous.
j. Perhaps, nodes can measure their energy level automatically

The procedures steps describe the proposed routing protocol:

1. In a articulat domain, diffuse all the sensor nodes.
2. After diffusing the nodes in such domain, the base station carries the start packet to all disperesed sensor nodes. Whereas, the initiate packet includes node identification number and session Id.
3. The base station chooses a cluster head for each expected cluster. The whole number of clusters in the sensor scope is around (3%) of the total number of sensor nodes in the range. CHs chosen step has two stages:

The first stage is: The base station selects the cluster head by taking in consideration the following parameters:

a. Distance between the sensor node and base station
b. The residual energy in the sensor node
c. How many times a sensor node becomes the cluster head?
d. How many sensor nodes the expected cluster head has as neighbouring?

The second stage is The distance between the chosen cluster head nodes. To determine the distance between two cluster head nodes, the received signal strength of the base station is compared and the primary goal of this to make sure the distribution of the cluster head nodes is a uniform manner in the sensor scope. As a result, the communication distance between nodes and cluster head will be approximately equal in the cluster. After the base station chooses the cluster head in stage one; the process passes through stage two to make sure the distribution of the cluster head nodes is a uniform manner in the sensor scope.

4. Base station report all the chosen cluster heads by broadcasting a packet which contains a node identification number, session Id and cluster head for each cluster.
5. Each chosen cluster head sends (invite to join) packets which include a node identification number and Session-Id.
6. CH's define node identity for sensors that are chosen by such a cluster after the clusters created by the base station. Cluster Figuration step is: the head cluster transmits an announcement packet (invite to join) which it is contained node identification number, session ID when the base station choses the CHs and as reported. Then, the sensors can receive all the signals from the cluster head sensors. Once it received all these signals, it will compare these signals and decide which one of them has the strongest signal. The head cluster which has the strongest signal will be the nearest one to the sensor. Therefore the sensor will choose the cluster head with the strongest signal to join it. In this way, all the clusters are established.

7. The cluster head produces the table of data transmission which is in the cluster and this table contains the node identification number with the time slot for transmission. Schedule a specific step is: assume the sensors are intensely spread. According to the large number of sensors, it is possible to produce some nodes to be sleeping in the sensing field without effecting on the efficiency of the network, and it will cover all the geographic areas of the sensing field. Any sensor has four states which are: Sensing, Sending, Receiving, and Sleep.
8. The cluster now can manage the sleeping list for some sensors, which belong to the cluster itself, after the cluster has reported from the base station about the proportional geographic position of the groups of its cluster. Based on the geographical position of the cluster, every cluster in the network will have a sleep table for each node. This procedure will save a lot of power for the sensors in the network and will increase the lifetime of the network itself. Moreover, if the sensor is not sleeping, at least the sensor does one task of the following procedure sending, sensing, and receiving. Therefore, the network will be active continuously.
9. As we mentioned, the head cluster establishes a TDMA based on the table for all other sensors which are not in a sleeping mode in its cluster. The cluster head CH always changes the table of the two schedules (TDMA and sleeping). The changing in the schedule depends on the transmission and sending a signal among the sensors' cluster member after a specific time period. At the start of the very first session, the period can be set up by the user (at the Base Station).
10. Data transmission for the session Id starts in hierarchical style. Sending data in Hierarchical design: Sending data usually run across two different ways. The first way is, the data transmit inside the cluster and the second way is, the data transmit from the cluster head CH to the base station (BS). Rely on the range of the space between the simple sensor and the cluster head, multi-hop data sending may happen even in the cluster.
11. The base station sent the topology of the cluster, based on this topology, the decision of multi-hop data transmission is made. Also, the data sending between the cluster head and the base station could be single-hop, or double-hop depending on the distance between them. The base station will decide and report to the cluster head based on the proportional distance between CH and BS.
12. Data transmission goes on to the present session. Terminate the present session: When the power of any cluster head decreased into the half of the amount of the initial energy during the start of the session, the present session will be terminated. The cluster head gives up the leadership of the cluster and report to the base station and transmits among the sensor under its leadership.
13. Repeat this scenario until (50%) of the total number of sensor nodes in the scope of death [35].

5. Results and Discussion

Through observe of the simulation, after working on many trials, based on the suggested scenario and the results that are concluded by the simulation. There is a significant improvement in the network performance. The advantage of using the movability in the wireless sensor network, in this proposed solution the moving of nodes will help in delivering the packets to the base station faster than the static.

The simulation was built to simulate the already build a solution from the writer. In addition, to show the expected results based on the suggested future work. The first run with 150 Node network and 5 base stations was initialized for the two simulations. See Figures 2 and 3. In the number of packets delivered per one unit of time is different from the number of packets in the static mode, based on the assumption that there is no power consumption during moving of nodes. On the other hand, the total power consumption for the two simulations almost the same. See Figures 4 and 5.

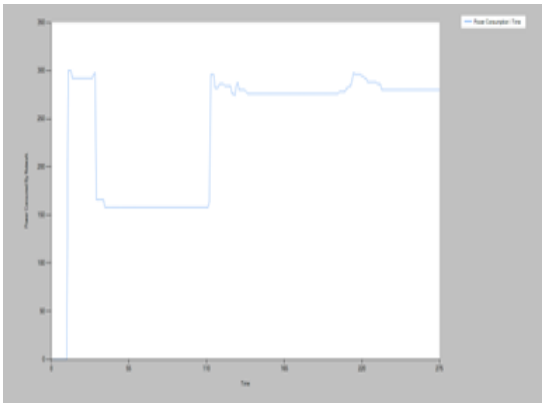

Figure 2. Static power consumption

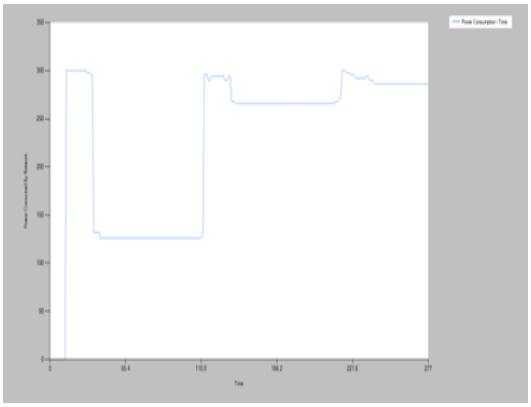

Figure 3. dynamic power consumption

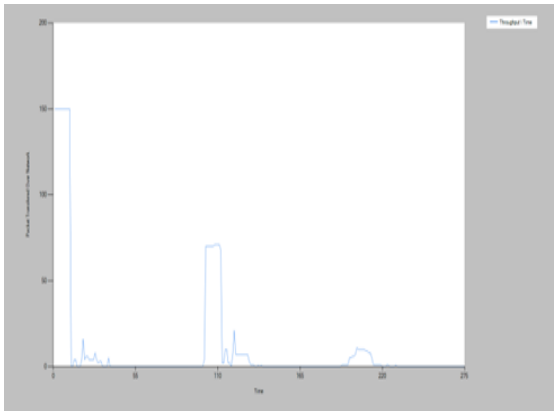

Figure 4. Static throughput

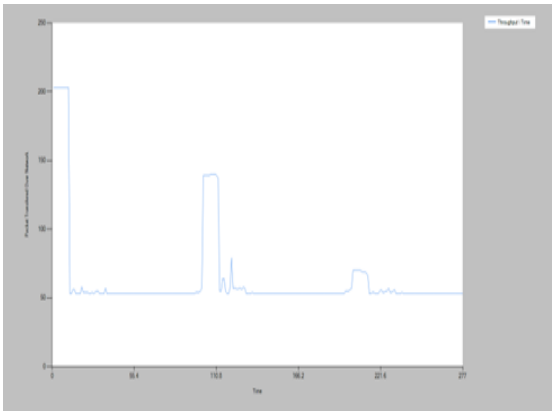

Figure 5. Dynamic throughput

6. Conclusions

The significant difference between the proposed solution and the future work solution is that the network performance will increase in the packet delivery. On the other hand, the power consumption will stay fixed in before and after applying the mobility in the algorithm. Therefore, the increase in the number of jobs gets completed in one unit of time reflect on the network performance, by increasing the usage of the network.

As future work for this paper, different architecture can be used instead of the same architecture (Homogenous) for both static and dynamic Wireless Sensor Networks WSNs. In addition, testing some changes in the proposed solution can be applied to monitor the changes in the delivering packets and power consumption. Also, sound quality sensors can be used to enhance the performance and the lifetime for the networks besides testing diffident environment to get the better result.

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