A Review: Energy Efficient Clustering Approaches For Maintaining Lifetime Of The Wsn

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Abstract: A Wireless Sensor Network (WSN) is a kind of specialized wireless network that is fabricated by using a large number of sensors. The only difference between the traditional wireless network and WSN is that the sensors of WSN are highly sensitive to the energy factor. This makes a energy efficiency as a crucial issue that needs to be considered and resolve while designing a wireless sensor network. It is preferable to implement the energy efficient clustering protocols to make an energy economical sensor network. This study is conducted to discuss the concept of energy efficiency in a network along with the various energy efficient clustering protocols such as Low Energy Adaptive Clustering Hierarchy (LEACH), Enhanced- LEACH (E-LEACH), Centralized- LEACH (C-LEACH), Power Efficient gathering in Sensor Information System (PEGASIS), Hybrid Energy Efficient Distributed (HEED) and Threshold sensitive Energy Efficient Network (TEEN). A review to the previous work also has been discussed in this paper.

Keywords: Wireless Sensor Network, Energy Consumption, Energy Efficient Clustering protocols.

I. Introduction

Wireless sensor network (WSN) can be portrayed as group of sensors which when implemented in the sensor field they work to monitor the particular parameters of the environment. After measuring these parameters the relevant information was collected. The WSN is newly emerged technology that had large scale application like protection of infrastructure, industrial sensing, monitoring the parameters of environment, context–aware computing etc. This type of network is mainly comprised of various nodes which are operated together to create a wireless network [1]. Apparatus of wireless sensor networks are referred as sensor nodes. The basic sensor node is comprised four types of elements i.e. first element is power unit, second is communication unit, third is processing unit and fourth is sensing unit. The power components are limited in number and are responsible for providing the energy to rest of the components so that the sensor node can operate effectively [2]. On the basis of application, the monitored event can be divided into two types of operation either static or dynamic. The number of sources in these types of sensors is limited whether it is battery power, computing ability or memory. All of these mentioned parameters are limited in the sensors but despite of these limitations the sensors can generate the real picture of all the determined parameters when implemented in large number [3]. The WSN needs some protocols to maintain the optimum performance of the network. For example, protocol can form the particular type of application with the specific order to combine the relevant information and make the energy consumption efficient. This type of protocol can be named as the hierarchical routing. In addition to this we also have one more protocol that is data centric routing protocol. It helps in describing the network environment in which the sensor node is dependent on data centric approach that operates in such a way that sensing application helps in determining the route path by using the multiple sources to reach the required destination [4]. Keeping this point in mind information from all the nodes in the network can be obtained by using the list of attribute value pairs known as attribute based addresses. This has been done in such a way that node can describe the availability of data to the whole sensor network. Moreover, it is required to increase the energy efficiency of WSN because the energy provided to the sensor is limited.

II. Why It Is To Be Energy Efficient

Energy effectiveness is one of the foremost aspects that need to be deemed while employing sensors in a WSN. The sensor in a network runs on the basis of the battery power that is consumed from batteries that are allotted to the nodes individually. It is not feasible to recharge or replace these battery cells when their energy is gets depleted once. The responsibility of the sensor nodes that are set up in a geographical site is to sense the data from its ambiance. Once if the sensor is deployed in the network than it becomes far flung from the operator [5]. The most crucial and leading necessity of the wireless sensor network are to control the energy consumption of the nodes. The less energy consumption of the energy will leads to an energy economical sensor network. The sensor nodes consume the energy to perform data gathering, data transmission and communication with sink node. Thus in this way the excess of energy is consumed by the nodes which could have worse effects

on the overall performance of the network. It makes the consideration of energy factor as a vital responsibility for the development of the WSN whether it is dynamic or adaptive in nature [6]. The designing of energy efficient network is most important to increase the lifetime of the network.

III. Energy Efficient Clustering Protocols

This section discusses some of the energy efficient routing protocols that are used in WSN. The major objective behind using energy efficient routing protocol is to reduce the energy consumption of the nodes without affecting the rest of the operations that are performed by the nodes.

A. **LEACH (Low Energy Adaptive Clustering Hierarchy):** LEACH is most pre-eminent energy adaptive clustering protocol. It is widely accepted by various authors for establishing their research studies. The working of this protocol is categorized in two phases i.e. setup and steady phase respectively. In setup phase the deployment of the network is performed and in steady phase the process of data dissemination is performed. Each and every node is independent to choose the candidate CH node in the network [7]. Then the CH selection is done from the candidate nodes on the basis of the threshold evaluation. Each node selects a value and then collates this with threshold value. If the selected number is lesser than the threshold then a node will be selected as a cluster head. The evaluation of threshold is done by using the following formulation:

$$T(n) = \begin{cases} \dfrac{P}{1 - P\left(rmod\dfrac{1}{P}\right)} & n \in G \\ 0 & : Otherwise \end{cases} \dots\dots\dots (1.1)$$

Where P; defined the desired percentage of CHs,
r: current communication round,
G: is the number of nodes that have not been Ch from last $\frac{1}{P}$ communication rounds.

B. **E-LEACH (Enhanced-LEACH):** This protocol is developed after performing enhancements in existing LEACH protocol. The improvements have done by adding two major functionalities. One is, it assumes that all the sensor nodes have the global information regarding energy level of all nodes. Another variation is that, in this protocol the number of CHs might be elevated square root of all sensors under certain circumstances. Thus it leads to the reduction in energy consumption of the nodes [8].

C. **C-LEACH (Centralized-LEACH):** The purpose behind developing this protocol is to resolve the global coordination problem that exists in LEACH. The information of residual energy and location of the sensors is shared with the base station. Then base station performs cluster formation, election of CH node and non CH nodes on the basis of the received information.

D. **PEGASIS (Power Efficient gathering in Sensor Information System):** In this the process of cluster formation is replaced with the process of chain formation. The chain formation is done either by nodes or base station using greedy mechanism. The data received from the previous node is forwarded using current node along with fusing their own data. The process of data transmission is initiated from farthest located node by assuring that the far located nodes have closer neighbors. If the energy of a node gets depleted then the chain is again formed by skipping the dead node. It increases the network lifetime twice in comparison to the existing LEACH protocol.

E. **HEED (Hybrid Energy Efficient Distributed):** This clustering protocol is used in wireless sensor networks which did not embraced of any communication overhead. Thus efficient distribution of CH is not implacable here. In this technique the cluster heads are selected on the basis of remaining energy on the sensor nodes. In case if any two sensor nodes with the same amount of remaining energy is located then in such cases the CH selection is done on the basis of the distance factor. This protocol can be implemented on homogeneous nodes only. The homogeneous nodes may be described as the sensor nodes containing same amount of energy [10].

F. **TEEN (Threshold sensitive Energy Efficient Network):** TEEN protocol was introduced for temperature sensing networks. Major disadvantages of TEEN protocol are:
   a) It can be deployed over the large scale network containing large number of sensor nodes hence not suitable for small scale networks.
   b) A large amount of energy is consumed
   c) The clusters formed by this protocol are unbalanced in nature.
   Reason behind the unbalanced cluster is that the CHs are randomly selected. By implementing TEEN protocol there is no increment in the lifespan of the WSNs as the cluster heads are not selected on the basis of residual energy of nodes [10].

Table 1 Comparison of energy efficient protocols [26]

Techniques	Cluster Stability	Energy Efficiency	Clustering Method
LEACH	Medium	Poor	Distributed
E-LEACH	Medium	Medium	Distributed
C-LEACH	Medium	Medium	Centralized
PEGASIS	Poor	Medium	Hybrid
TEEN	High	Very High	Distributed
HEED	High	Medium	Distributed

IV. Literature Review

Wendi B. Heinemann, (2002), "An Application-Specific Protocol Architecture for Wireless Micro-sensor Networks", [9] developed and analyzed the LEACH protocol with respect to topology of the network. The LEACH is a protocol that collaborate the idea of energy efficient CH selection and data aggregation. LEACH comprised of distributed cluster formation strategy that is capable to organize the large number of nodes, algorithm to implement the adaptive clustering and rotation of the CHs so that the load can be distributed evenly in the network. After getting the results, it has been concluded that the LEACH can leads to improvements in lifetime of the network.

Liliana M (2006),"Comparison of clustering algorithms and protocols for wireless sensor networks", [10] defined that the clustering is a strategy that is used in WSN for reducing the energy consumption of the network and to produce the network with the efficient functioning. The nodes in a network were assumed to save the energy of the network by controlling the operations of the network. Whereas it is quite easy to decide when to act as a cluster head and when to act as a energy saver. To make this decision it is mandatory to consider some major aspects such as energy of the nodes, data transmission schedule etc. This study was organized to study some basic terminology related to both clustering process and clustering techniques.

Rashmi Ranjan Sahoo, (2013), "Tree-Cr: Trust Based Secure And Energy Efficient Clustering In Wsn", [11] a trust based secure cluster head selection mechanism is developed to resolve the issues of lifetime and proficiency of the network that occurs due to the higher consumption of energy by their nodes. The proposed technique was named as TREE-CR. The proposed work was designed in such a way that it has the capability to secure the network from various malicious attacks that occurs through malicious nodes. The work also provided a energy model for enhancing the lifetime of the network. A comparison among LEACH and TREE-CR has been driven in this work.

Meena Malik, (2013), "Analysis of LEACH Protocol in Wireless Sensor Networks", [19] depicted that the WSN can be created by using the tiny devices that are named as nodes or sensors. It can be distributed in nature. It attracts a large number of researchers due to its expanding nature of applicability. This attraction leads to the development of energy efficient clustering techniques. The author selects the LEACH protocol to describe it in detail. This study provided a contrast study of various network performance parameters in the form of tables and graphs.

Hunyao FU,Zhifang (2013), "An Energy Balanced Algorithm of LEACH Protocol in WSN", [20] said that the energy is the most indispensable constraint to deem while designing an energy efficient network model. It is essential to consider because it is the only resource of energy in WSN that is replaceable and refillable if once get exhausted. The author offered an improved version of LEACH protocol in order to resolve the issues that exist in traditional LEACH. The proposed work spread the energy evenly in the network. After having results of the simulation, it was observed that the proposed system enhanced the network lifetime with respect to the traditional LEACH protocol.

Shounak Chakraborty, (2014) "A Noble Approach for Self Leaming and Cluster based Routing Protocol with Power Efficiency in WSN", [21] stated that Energy efficiency is the main deliberation while mounting routing protocol for a WSN. For self learning, steady clustering power competent routing procedure a statistical model was projected. This model was known as statistical model because it was based on various statistical functions like mean, variance and standard deviation to constrict the data for dissemination and a threshold value to engender an alarm in case of urgent situation. This technique utilized the statistical output of collected data and used it in case of emergency that it automatically spawned the alarm or alert to the sink node regarding it. The algorithm also cracks the predicament of analogous generation of both periodic and event driven data. A simulation was done to firm up the protocol in which it was obtained that this protocol leads to improved power efficiency.

Ping Yang, (2015) "An Energy Effective Routing Algorithm for Event-driven Wireless Sensor Networks", [23] is obligatory to implement the efficient routing technique to the WSN so that the network can perform effectively and must able to stay for long. In this work, the focus of the author was to develop a real time based cluster formation technique by managing the events in a format. The best side of this technique was that it worked by considering all the relevant parameters such as energy, distance, strength of the received signals and all other. After performing a test of the proposed work on MATLAB, it was observed that the network lifetime has been boosted by 16% in comparison to the TEEN.

Hassan El Alami, (2016), "Energy-efficient fuzzy logic cluster head selection in wireless sensor networks", [25] defined that various author did some efforts to create such a topology for WSN that have the feature of energy saver and can also lead to the increment in the longevity of the network. Clustering algorithm and routing schemes are steps towards this direction. This work provides energy efficiency based fuzzy logics cluster head election technique. The three factors i.e. remaining energy, expected efficiency and distance were used as an input membership function to FLS. The comparison was drawn in between EEFL-CH, LEACH and LEACH-ERE.

V.   Conclusion

After having a deep discussion on the topic of energy consumption, it is concluded that the reduction of energy consumption is the major task to perform in the WSN. The reduction of energy consumption can enhance the lifetime and reliability of the network. This can be done by implementing various available energy efficient clustering protocols. After having a review to the previous work that had been done in this field, it is observed that the LEACH protocol performs the CH selection on the random basis. Another observation is that in past studies only energy is considered as a major factor for electing the CHs. Thus in near future more amendments can be done in present LEACH approach by modulating the list factors that influences the CH selection. This can be achieved by using any artificial intelligence mechanism along with energy efficient cluster head selection protocol.

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