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A REVIEW ON STUDY OF ENERGY EFFICIENT CLUSTERING APPROACHES FOR WIRELESS SENSOR NETWORK

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Abstract – *These days wireless senor networks has attention of researchers all over the world because of trending applications and tremendous benefits to the society. A balanced tradeoff is required in energy dissipation, accuracy and latency in data transmission in wireless sensor network. In these networks, sensors are battery operated. So, these networks are energy constrained. In order to reduce the energy consumption and extend the lifetime of the network, research is required to devise the enhanced routing protocol. This paper provides the review on various clustering protocols devised in recent years.*

Key Words: CH, SN, HWSN, WSNs, DEEC, EDEEC, DDEEC, REEH

INTRODUCTION

In wireless sensor network the main goal of research is to minimize the energy consumption of sensor nodes by designing the energy efficient routing protocol. Wireless sensor network represents the group of sensor network where the size of network can vary from a few to thousands [1-3]. Clustering can reduce the significant amount of the energy consumption in WSN. Wireless sensor network consist of a large number of sensor nodes, which are connected wirelessly to collect the information from the sensing field.

Many attributes like the size of clusters can affect the energy consumption in sensor nodes. These attributes can be the size of the cluster, distance of member nodes from the cluster head, distance of the base station from the cluster head. Larger the distance from the member nodes from the cluster head greater the energy dissipation for the data transmission.

There are two classification of wireless sensor network in terms of energy of their sensor nodes i.e. homogeneous wireless sensor networks and heterogeneous wireless sensor networks. Homogenous WSN have the equal energy and heterogeneous WSN have the different energy of the sensor nodes.

The sensor nodes in these networks can sense the physical environments conditions like temperature, humidity, light, sound and vibrations etc. These sensors can replace the human physical monitoring in the hazardous situations like forest fire, flood, guarding on the border, monitoring the volcanoes eruption. Some other applications are military, structure health, industrial, child care, medical monitoring, food processing, and surveillance. NFC is the new trending application of wireless sensor network for payment, keyless door cards, smart posters, health monitoring by smart bands equipped with NFC technology.

2. RELATED WORK

a) LEACH

This protocol is proposed by W.R. Heinzelman *et al i*n 2000 [4]. It is very famous protocol in wireless sensor network for clustering. This protocol offers both centralized and distributed schemes. LEACH is designed for homogenous WSN i.e. all the sensor in the network have the same energy. LEACH uses the concept of making clusters depending on the received signal strength of the SNs and then use the other intermediate cluster heads as routers to relay the sensed data to BS. Tasks like data fusion and compression is the responsibility of Cluster Head. This mechanism saves the energy as the data transmission is carried by the CHs nodes rather than all the SNs.

The optimal number of cluster head in LEACH protocol is calculated by the 0.05 times of the total number of sensor nodes in the wireless sensor network. For load balancing in LEACH, cluster head is keep on changing randomly, this method also saves the energy of the network. LEACH has two advantages that it does not need the global knowledge of network and it is completely distributed.

b) TEEN

This protocol is proposed by A. Manjeshwar *et al* 2001 [5]. TEEN protocol was developed for reactive WSNs. This is a location aware protocol and developed by authors for reactive networks and time critical applications. TEEN incorporates the same concept of LEACH for cluster formation and CH selection of nodes. TEEN have two types of threshold in protocol, hard threshold (HT) and soft threshold (ST) along with the current sensed value. HT is the threshold value to trigger a sensor node to transmit the sensed value to corresponding cluster head if the sensed value is greater than the hard threshold. Soft threshold is a value which is a minute change in the sensed attribute to switch ON it transmitter of current sensor node for data transmission.

The TEEN protocol send the value of sensed parameter to the base station, when there is sudden and significant change in the threshold value of that parameter higher than or equal to the set threshold, then sensor node switch on its transmitter to send the required information to the base station. We can get more accurate results by changing the soft threshold to a smaller value but it costs more energy consumption. On simulation TEEN outperforms LEACH and LEACH-C on average energy dissipated and total number of nodes alive metrics.

c) APTEEN

This protocol is introduced by A. Manjeshwar et al in 2002 [6]. APTEEN is the enhance version of TEEN protocol, it send the sensed periodical data at regular time interval and it can be used in both application either proactive or reactive. APTEEN has a disadvantage over TEEN that it consumes more energy than TEEN because it sends the sensed data periodically. This protocol have four parameters i.e.- hard threshold, soft threshold, current value and the count time. APTEEN has one more parameter than the TEEN which is count time. Count time is a counter which is a time duration after which the node sends the sensed value to the CH whether it reaches the threshold or not. In this way it gives the solution for real time applications but at the cost of more energy dissipation.

d) DEEC

This protocol is proposed by Li Qing *et al* in 2006 [7]. The authors presented DEEC (Design of a distributed energy-efficient clustering) algorithm for heterogeneous wireless sensor networks. The authors developed DEEC protocol, which is a hierarchical protocol for two and more energy levels in heterogeneous WSNs. DEEC protocol distributed the high energy task of CHs among all the nodes in network according to their residual energy and initial energy of the nodes. DEEC have two types of nodes normal and advance, advance nodes has (1+a) times more energy. So the advance nodes has high initial and residual energy , so they have greater probability for being selected as a CH. CH election is based on a probability expression which is a ratio of current node residual energy and average network energy..

e) DBEC

This protocol is proposed by Changmin D *et al* in 2007 [19]. The authors innovated a heterogeneous and energy efficient protocol named as "Distributed Energy Balance Clustering Protocol for Heterogeneous Wireless Sensor Networks". The author proposed a DEBC protocol for heterogeneous wireless sensor network. The selection of cluster heads depends on the probability based on ratio of remaining energy of the sensor to the average energy of network. Rather than the low energy nodes the high remaining and initial energy nodes have more possibilities to be elected as cluster. This protocol improves the LEACH and SEP protocol by considering heterogeneity for two levels and extends up to multi-hop heterogeneity. This protocol can also be extended as two-level heterogeneity and multi-level heterogeneity in terms of energy of the nodes which can produce much better results in future.

f) REEH

REEH protocol is developed by Lalitesh Sehgal *et a*l in 2011 [8]. It is devised for heterogeneous wireless sensor networks. This heterogeneous clustering protocol is based on the concept of residual energy of the network. The author analysed the effect of heterogeneity in energy of nodes to extend the life time of WSN is described. The author devised the REEH protocol which is heterogeneous in energy of nodes on comparing from the LEACH protocol. The selection of the CH is based on the residual energy of the node and their respective cluster. There are two types of nodes normal and advance. There 100 nodes out of which 10 are advance and 90 are normal nodes. Normal nodes have 2 joule and advance nodes have 4joule of initial energy i.e. two times of normal node's energy.

The research work shows its efficiency on these parameters which are first node die, half nodes alive, last node dies. These three parameters describes the network lifetime at different stages of network deployment. On the

simulation of REEH on NS2.27 platform shows that when REEH compared to the homogeneous LEACH protocol, REEH lowers the energy dissipation and prolong the total network lifetime.

g) ECRPW

This protocol is introduced by Sun Yanjing, He Yanjun *et al* in 2011 [9]. The authors devised a protocol named ECRPW**,** an energy efficiency clustering routing protocol based on weight for WSNs. ECRPW protocol is heterogeneous in energy of sensor nodes and sets up a routing tree based on cluster heads' weight. In ECRPW routing protocol author employ two types of sensor nodes normal and special nodes. There λ is the number of special nodes, and energy of special nodes is α times more than that of the normal nodes. This protocol chooses the cluster head on the basis of remaining energy of the sensor nodes after every round. ECRPW has also applied a constraint of distance threshold in forming the clusters. This routing protocol efficiently extends the longevity of network lifetime in heterogeneous wireless sensor network. ECRPW shows better results on simulation on NS2 than LEACH, LEACH-C in terms of energy expenditure of network, death ratio of node and lifetime of network.

h) ESEP

ESEP is proposed byM. M. Islam *et al* in 2012 [11]. The authors devised a energy efficient protocol named as "Extended Stable Election Protocol (ESEP) for Three level Hierarchical Clustered Heterogeneous WSN". ESEP is a three level heterogeneous protocol in HWSN. ESEP has three types of nodes normal, moderate and advance nodes. The higher energy nodes i.e. moderate and advance nodes have more chances to become cluster head due to their high initial energy. ESEP also considers the remaining energy concept accordingly the increasing number of rounds in WSN. On simulation ESEP protocol produces better results in terms of network lifetime, on comparing with traditional SEP.

i) MODLEACH

This protocol is proposed by Mahmood, N. Javaid *et al* in 2013 [10]. The authors devised a protocol named as MODLEACH: A Variant of LEACH for Wireless Sensor Networks. MOD-LEACH is a modified and enhanced version of LEACH which is a very renowned protocol in hierarchical clustering routing protocols in WSN. MOD-LEACH has a threshold for cluster head replacement scheme after every round with dual transmitting levels. . If current CH has not dissipated much energy during that round and if the CH has more energy than required threshold, it will remain cluster head for the next round also. The MOD-LEACH protocol is more robust than LEACH on terms of packets sent to the base station, formation of the cluster head and stability of the network with longer lifetime of sensor nodes. Further advancement in the protocol is made by incorporating the hard and soft threshold concept of the TEEN protocol for reactive WSNs. Then there will be two new versions of the MOD-LEACH i.e. hard threshold MODLEACH and soft threshold MODLEACH. On comparison with the help of simulation these outperforms the traditional leach metrics of throughput and network life.

j) EDDEEC

This protocol is proposed by N. Javiad *et al* in 2013 [17]. The authors proposed EDDEEC (Enhanced Developed DEEC) for HWSNs. This approach is an enhanced version of EDEEC and DDEEC named as EDDEEC. In EDDEEC, it removes the penalizing effect of DDEEC and has the three types of energy nodes in EDEEC with a new threshold called absolute threshold. On simulations it shows better results than previous algorithms.

k) BEENISH

This protocol is proposed by T. N. Qureshi *et al in* 2013 [18]. The authors devised BEENISH (Balanced Energy Efficient Network Integrated Super Heterogeneous) Protocol for WSNs. In BEENISH CHs are elected on the basis of distinct five types of probabilities for five types of different nodes. It propose four energy levels of nodes in WSN, the new forth level energy node group is ultra super nodes which has the highest energy level in WSN. Simulation shows that it outperforms DEEC variants.

l) TADEEC

This protocol is proposed by Chauhan A. *et al* in 2013 [13]. The authors introduced TADEEC: Threshold Sensitive Advanced DEEC Protocol for WSNs. TADEEC protocol is a heterogeneous protocol with four energy levels. In this paper the author presents a super advanced node with the existing three types of nodes likewise in EDEEC. They also used the concept of TEEN (reactive protocol) in TADEEC with four level of heterogeneity. TADEEC outperforms LEACH, DEEC and EDEEC on lifetime and stability parameter.

m) HEER

This protocol is devised by N. Javaid, S. N. Mohammad *et al* in 2013 [14]. The authors proposed HEER (Hybrid Energy Efficient Reactive) Protocol for Wireless Sensor Networks. The authors developed a protocol for homogeneous and reactive wireless sensor network. This protocol is not energy aware about the energy of the network. It incorporates the features of DEEC and TEEN protocol. From DEEC, HEER protocol uses the CH election technique based on the residual energy of the nodes in WSN and from TEEN it uses the hard and soft threshold concept.

n) ACH

This protocol is developed by N. Javaid *et al* in 2013 [12]. The authors introduced ACH: Away Cluster Heads Scheme for Energy Efficient Clustering Protocols in WSNs. The author proposed a scheme to a new arrangement to sensor nodes in a way that two cluster heads are maintain a distance of 12 m minimum, so in this way CHs are distributed in a balance manner in wireless sensor network. ACH scheme is applied on LEACH, SEP and DEEC and then compare with conventional LEACH, SEP and DEEC. On comparison LEACH-ACH, SEP-ACH and DEEC-ACH gives better results in terms of stability and number of packets sent to the Sink.

o) ZSEP

This protocol is proposed by G. Chandini *et al* in 2014 [16]. The authors introduced Energy Efficient Zonal Stable Election Protocol for WSNs. The authors proposed the energy efficient routing protocol Zonal Stable Election Protocol (ZSEP). In which they categorized the network into three regions. One zone in network contains the normal nodes and remaining other two zones contains the advance nodes according to their energy levels. The base station is deployed in the center is stationary in sensor area. If the normal nodes want to send their sensed data to BS, they have the privilege of direct communication to BS. If the node comes in other two zones which have the advance nodes then they will forward data to CH and relay their data to BS through the CH. ZSEP shows better results from the existing protocols in terms of energy metrics.

p) iP-EDEEC

This protocol is proposed by Anamika Saini et al in 2016 [20]. The authors proposed the iP-EDEEC protocol for heterogeneous wireless sensor networks. This protocol is a enhanced and improved version of EDDEEC using TEEN protocol as optimization protocol for threshold data transmission to reduce the unnecessary and redundant data to the base station. The iP-EDEEC protocol outperforms the conventional DEEC variants on the stability period, network lifetime and throughput.

3. CONCLUSION

This literature review gives a summarized form of all the research papers based on distributed clustering protocols in both homogenous and heterogeneous wireless sensor network environment, which helps researchers to find the research gaps in the previous work for more improvement. From the above literature, we studied these research paper in a detailed manner by which we inferred that the current research and development (R&D) field is to develop low-power communication protocols with inexpensive on-node processing and limited power supply. We studied that the CH selection and many other factors are taken in to consideration to choose the best set of CHs, thereby the network lifetime of the WSN can be increased.

We conclude from the above literature review that the heterogeneous clustering protocols outperform the homogeneous clustering protocols in extending the lifetime and stability. As the heterogeneity of the sensor nodes in terms of initial energy increases the network lifetime also increases.

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