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A Review on Weight Based Clustering Algorithms in Wireless Sensor Networks

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Abstract: In past few years, Wireless sensor networks (WSNs) is growing enormously in order to achieve aforementioned WSN related purpose such as improved network lifetime and energy efficient network. This is challenging task in WSNs due to its resource restriction. The objective of this paper is to present some modified weight based clustering algorithms (WBCAs) those are initiated from mobile ad-hoc network (MANET). WBCAs consider several different parameters such as transmission power, number of neighbour's nodes and remaining energy etc. to select a cluster head (CH), which is more beneficial compared to other clustering algorithms that consider one or two parameters into account.

Keywords: Wireless Sensor Networks, Combined Weight Function, Network Lifetime, Cluster Head.

I. INTRODUCTION

Wireless Sensor Networks (WSNs) [1] is a densely deployed communication network, which consists of several nodes and responsible for gathering information from their surroundings. All of this information is sent to the sink node so that it can be accessed by the end user only. WSN has several applications such as military reconnaissance, industrial automation, security surveillance, disaster management, habitat monitoring, medical and health care monitoring, environmental/earth sensing [2],[3] etc.

A WSN node combines sensing, computation and communication into a single tiny device. Prolonged network lifetime, load balancing, scalability and minimum energy consumption are important requirements for various WSN applications. Minimum energy consumption and Maximum network lifetime are two important objectives of WSNs. So the elegant approach is clustering in which network is divided into disjoint groups and each group is managed by a representative node known as CH and others are member nodes.

In two levels hierarchical approach, only CH nodes communicate directly to the base station (BS), so energy consumption is more than that of member nodes. Therefore, selection of CH plays an important role in all clustering algorithm for efficient performance in WSNs. There are several clustering algorithms running on mobile ad-hoc networks (MANETs) and WSNs. This paper objective is to study of different WBCAs which are frequently cited for the purpose of forming cluster in WSNs and concentrating on energy efficient clustering by considering several parameters.

MANET VS WSN:
Some differences and similarities between MANET and WSN are listed below:

Similarities are:
(i) Both are infrastructure less networks.
(ii) Both uses wireless links for communication.

Dissimilarities are:
(i) MANET has less network density in comparison to WSN.
(ii) Data traffic in MANET is higher than data traffic in WSN, because using services like web, mail, video, etc.
(iii) Sensor nodes in MANET are computation devices, whereas in WSN they are cheap tiny nodes.
(iv) Energy issues in MANET have less importance in comparison to WSN because energy in tiny sensor node is very restricted.

The purposes of running clustering algorithms on these two types of networks are different. WSNs mostly concentrate on how to sense the environment and send the aggregated data to the sink node, aiming to increase of the network lifetime and the energy efficiency of sensor network.

The rest of the paper organized as follows: Section II describes a brief overview of existing WBCAs in MANET. Section III presents the clustering in WSNs and some important characteristics of cluster formation such as cluster count, cluster size etc. these are related to internal structure of a cluster. Section IV examines existing WBCAs in WSNs proposed so far with combined weight function and objective of each algorithm in WSNs. Finally section V describes the conclusion.

II. RELATED WORK

In the past, large amount of research carried through WBCAs in MANETs. Every algorithm has its own

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specific goal. This section reviews all the related weighted clustering algorithms (WBCAs) in brief. These are as follows:

M. Chatterjee et al.2000 [4],[5] proposed the first weight based clustering algorithm named as on-demand weighted clustering algorithm (WCA) for selecting CHs in mobile ad-hoc networks (MANET). Sensor networks generally have more constraints than traditional networks. Thus, WCA always is not so appropriate to apply directly in sensor networks. A MANET can be represented as a graph, composed of nodes and links. The following formula is used to calculate the combined weight function w_v of a node v as a CH:

$$w_v=w_1\Delta_v+w_2D_v+w_3M_v+w_4T_v$$
$$w_1+w_2+w_3+w_4=1(I)$$

In (I), where v is the serial number (ID) of a mobile node, Δ_v is the degree difference of node v, D_v is the sum of the distances between v and its neighbour's, M_v is the mobility speed of node v, T_v is the cumulative time in which node v acted as a CH, and w_i is the weighted coefficient for the i-th factor. w_v is used to determine the goodness of a node as a CH. The lower the w_v value is, the better v acts as a CH.

H. Safa et al.2008 [6] proposed an algorithm named as dynamic energy efficient clustering algorithm (DEECA). It has two phases: cluster formation and network maintenance. The main aim is to achieve the load balancing to the CHs by defining the two energy thresholds within the network.

L. Zou, et al. 2008 [7] proposed an algorithm known as Improved weight-based clustering algorithm (IWCA). Its main aim is to reduce the high rate re-affiliation that leads to increased network overhead.

C. Li, et al. 2009 [8] proposed an algorithm known as enhanced weighted clustering algorithm for mobile networks (EWCA). Its main aim is reduce the overhead during the cluster formation, increase the cluster stability and increase the network lifetime of the ad-hoc network. Y. Fayyaz, et al. 2010 [9] proposed an algorithm known as maximal weight topology discovery in ad hoc wireless sensor networks (Max Weight). The main aim of this algorithm is to minimize the number of CHs to get the optimal topology in the network. P. Sivaprakasam et al. 2011 [10] proposed an algorithm known as Efficient cluster-head election algorithm (ECAM). It has two phases cluster formation and maintenance. It uses mobility of the cluster, cluster maintenance important parameters during the maintenance stage.

III. CLUSTERING IN WSN

In clustering, the sensor network is divided into different clusters. Each cluster is having a representative node known as CH and other are cluster members. Member nodes do not communicate directly with the sink node or BS. They have to forward the aggregated data to the CH. The CH will perform aggregation of the received data from member nodes and sends it to the sink or BS. The basic clustering topology is shown in Fig.1.

Some important characteristics of cluster formation related to the internal structure of the clusters are described below.

A. Properties of clustering

In cluster-based approaches, there are some characteristic for the cluster formation. These are related to the internal structure of the cluster. Some important characteristics [11] are as follows:

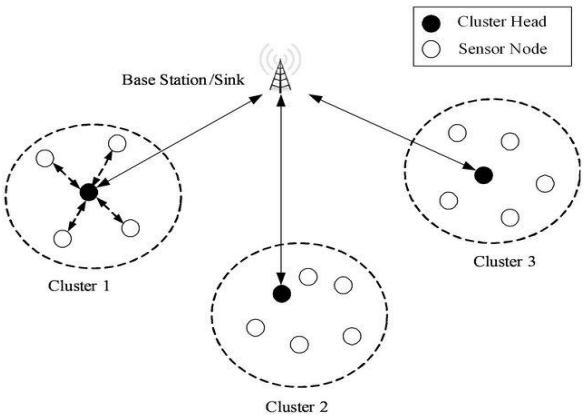

Fig1. The Basic Clustering Topology in WSN

Cluster count:Cluster count is the number of clusters formed in a round. More number of cluster leads to small size cluster distribution, which is better in term of energy consumption.

Cluster size:Cluster size is the maximum path length among the member nodes from CH. Small sized cluster is better in term of energy consumption because it minimizes transmission distance.

Cluster Density:Cluster density is defined as proportion of the number of cluster member in the cluster. In WSN, it is a big challenge to minimize the energy consumption in dense clusters.

Message count:Message count is the number of message transmission is requiring for CH selection. More number of message transmission leads to large amount of energy consumption for CH selection procedure.

Stability:If the cluster members are not fixed the clustering schemes are said to be adaptive. Otherwise, we can consider it as fixed because the cluster count is not varied throughout the cluster ring process. The fixed number of clusters increases the stability of a WSN.

Intra-cluster topology:It indicates the communication within the clusters either single hop or multi hop, from one

sensor node to other sensor node or one sensor node to CH. However, this communication also depends on the range of sensors.

Inter-cluster head connectivity:It indicates the capabilities of sensor nodes/CHs communication to BS.

B. Clustering objective and advantages

In contrast to flat routing schemes, cluster-based routing scheme is having variety of advantages. Therefore, we summarize the advantages and objectives [11],[12] of WSN clustering schemes are as follows:

More Scalability:Cluster-based routing scheme is more scalable as compare to flat topology. It is very easy to manage the events in the network.

Data Aggregation/Fusion:Data aggregation is the most popular method in which each CH performs the data aggregation, and sends it to the BS. It saves significant amount of energy.

More Robustness:Cluster-based routing schemes should be dealt with any network changes, unpredictable failure, node mobility etc. Routing schemes only have to do with these changes within individual cluster, in such a way robustness is achieved in entire network.

Collision Avoidance:Sensor network is divided into clusters and communications among nodes involves two modes i.e. intra-cluster and inter-cluster, for the purpose of data gathering and data transmissions respectively.

Load Balancing:Load balancing is an essential requirement in WSNs, aiming to increase the network lifetime. In cluster creation, approximately equal distribution of sensor nodes is usually considered. Further, CHs performs the intra-cluster management. Generally uniform clusters are adopted for increasing the network lifetime.

Guarantee of Connectivity: Due to the connectivity of each node, data is successfully delivered to the base station determines by the connectivity of each node along the path.

Maximum Network Lifetime:Network lifetime is most important requirement in WSNs, because limited power source of sensor nodes, transmission bandwidth and processing capability mainly for the applications of harsh environment.

IV. OVERVIEW OF EXISTING WEIGH BASED CLUSTERING ALGORITHMS IN WSN

In WSNs, various clustering algorithm has been proposed. These can be classified as deterministic or randomized, where deterministic method uses the combined weight function to determine the CH. Each node sends the calculated weight value. Thus, decision is made based on calculated weight function, whether the node became a CH or cluster member.

In this section, various WBCAs discussing their features and their associated weight functions. Special emphasis is put on the issues of lifetime and energy efficient clustering as these are the most important issues need to focus in the present research work.

A. Clustering Algorithm for Localization in Wireless Sensor Network (CFL)

The CFL was proposed by S. Zainalie et al. [1]. The main aim of CFL algorithm is achieving the minimum number of clusters with maximum number of nodes in each cluster in order to improve the performance of clustering algorithm. When CFL algorithm starts, all nodes broadcasting the 'Hello' message throughout the network and making their neighbours' table on the basis of received message and also include the estimation of distances. Then each node calculates its weight value using following formula:

$$W_i=aN_i+bE_i+c1/P_i;\ (a+b+c\leq 1) \qquad (1)$$

In equation (1), where E_i is the remaining energy, N_i is the number of neighbour's node, P_i is the transmission power and W_i is the combined weight function. At the end, the node with the maximum weight value acts as a CH and sends a cluster message to its neighbour's and the nodes that receive this message change their states to cluster members. The remaining nodes, which do not belong to any clusters, change their state to CHs.

B. Improved Weighted Clustering Algorithm for Heterogeneous WSNs (IWCA)

The IWCA was proposed by T. Hong [13]. The main aim of IWCA is to increase the network lifetime and it includes network maintenance phase in addition to cluster formation phase. Network maintenance phase checks two thresholds for energy amount of nodes, which leads to the recalculation of the clustering algorithm. Each node calculates its weight value w_v using following formula.

$$w_v =w_1\Delta_v+w_2D_v+w_3M_v+w_4T_v+w_5C_v;$$
$$w_1+w_2+w_3+w_4=1 \qquad (2)$$

In equation (2), where Cv is the characteristic C of each node which is calculated as $C_v=(C * r_v)/E_v$,where C is a constant for amplification, r_v is the transmission rate, E_v is the initial energy of a node.

D_v is the sum of distance with its neighbour's, Δ_v is the degree-difference, M_v is the speed of a node and T_v is the cumulative time which shows how long a node acts as a CH in a network. The node with minimum weight value acts as a CH and makes its cluster.

C. Life Time Sensitive Weighted Clustering on WSN (LTS-WCA)

The LTS-WCA was proposed by E. Alizadeh [14]. The aim of LTS-WCA algorithm aim is to solve the problem

involved in reviewed weighted clustering algorithm and increasing the network lifetime. It is a fully distributed algorithm and applicable for both homogeneous and heterogeneous network. There are various modifications on the original version,which are listed below:

(i) LTS-WCA makes decision based on local minima instead of global minimum.
(ii) There is a specific lifetime to every protocol packet of a node.
(iii) In both intra- and inter-communication, Sensor nodes communicate in a multi-hop fashion.
(iv) To calculate the weights several additional parameters are included in the clustering algorithm. The additional parameters are:

- E_r: remaining energy of a node.
- T_r: transmission range of a node.
- S: size of a cluster which a node can support when acts as a CH.
- d_v: number of 1-hop neighbors of a node.

Each node recognizes its neighbour's node and calculates its parameter as $S = (NK^2T_r^2\ \pi)/A$, where S is the size of cluster when a particular node elected as a CH and N is the number of neighbours'nodes. A is the area of the network where nodes are deployed and T_r is the transmission range of a node. Each node calculates its weight value w using following equation.

$$w=(w_1T_r+w_2M_v)/(w_3d_v+w_4E_r+w_5S);$$
$$w_1+w_2=1,\ w_3+w_4+w_5=1 \qquad (3)$$

In equation (3), where M_v is the speed of a node, E_r is the amount of residual energy of a node, d_v is the number of 1-hop neighbour of a node. Node with the minimum weight value acts as a CH and send cluster message to its neighbour's including its ID. Number of nodes within its cluster should not exceed the defined threshold.

D. Distributed Energy-Efficient Hierarchical Clustering for WSNs(DWEHC)

The DWEHC was proposed by Ding et.al [15]. The main aim of this algorithm is to minimum energy consumption. This algorithm utilizes two parameters these are: residual energy and distance with neighbour's. The combined weight function for each node can be calculated as follows:

$$w_{weight}\ (S) = \left(\sum_{u\epsilon N_{\alpha,c}(S)} \frac{(R-d)}{6R}\right) \times \frac{E_{residual}\ (S)}{E_{initial}\ (S)} \qquad (4)$$

In equation (4), where R defines the cluster range, d specifies the distance from node S to the neighbouring node u, $E_{residual}$ is the residual energy of node S, $E_{initial}$ is the initial energy in node S which is the same for all the nodes, $N_{\alpha,c}$ is the set of the neighbour'snode S where α is equal to 2 or 4 and c is a constant. It is assumed that the number of neighbouring nodes of a cluster is at most 6.

V. CONCLUSION

This paper critically analyse that weight based clustering algorithms are energy efficient technique in sensor network because it consider several parameters in a combined weight function for selecting a cluster head.Most of the WBCAs are aiming to form less number of CHs because it uses less transmission power thus network lifetime of WSNs get improved.

There is still less research done in this area. Furthermore, improvements on WBCAs should concentrate on cluster formation and CHs election for creating a more stable network structure with less energy cost.

Efficient thresholds should be used in terms of energy amount of nodes and calculating the combined weight function with some other parameters may help to keep the amount of load balanced on the cluster heads.

REFERENCES

[1]. S. Zainalie and M. H. Yaghmaee, "CFL: A Clustering Algorithm For Localization in Wireless Sensor Networks", Internatioal Symposium on Telecommunications IEEE, 978-1-4244-2751-2/08, 2008.
[2]. N. Saini and J. Singh, "A Survey: Hierarchal Routing Protocol in Wireless Sensor Networks", Global Journal of Computer Science and Technology: E Network, Web & Security, Online ISSN: 0975-4172 & Print ISSN: 0975-4350, Volume 14 Issue 1 Version 1.0 Year 2014.
[3]. P. Patil, "Some Issues in Clustering Algorithms for Wireless Sensor Networks", IJCA Special Issue on 2nd National Conference-Computing, Communication and Sensor Network (CCSN), vol. 4, pages 18–23, 2011.
[4]. M. Chatterjee, S. K. Das, and D. Turgut, "An on demand weighted clustering algorithm (WCA) for ad hoc networks", Proc. of the IEEE Global Telecommunications Conference, 1697–1701, 2000.
[5]. M. Chatterjee, S. K. DAS and D. Turgut, "WCA: A Weighted Clustering Algorithm for Mobile Ad Hoc Networks", Cluster Computing 5, 193–204, 2000.
[6]. H. Safa, O. Mirza, and H. Artail, "A dynamic energy efficient clustering algorithm for MANETs", IEEE Int. Conf. on Wireless and Mobile Computing, Networking and Communications (WIMOB'08), 51-56, 2008.
[7]. L. Zou, Q. Zhang, and J. Liu, "An improved weight-based clustering algorithm in MANETs", 4thInt. Conf. on Wireless Communications, Networkingand Mobile Computing (WiCOM'08),1-4, 2008.
[8]. C. Li, Y. Wang, F. Huang, D. Yang, "A novelenhanced weighted clustering algorithm for mobile networks", 5th Int. Conf. on WirelessCommunications, Networking and Mobile Computing(WiCom'09),1-4, 2009.
[9]. Y. Fayyaz, M. Nasim, and M. Y. Javed, "Maximalweight topology discovery in ad hoc wireless sensornetworks", IEEE 10th Int. Conf. on Computer andInformation Technology (CIT'10), 715-722, 2010.
[10]. P. Sivaprakasam, and R. Gunavathi, "An efficient cluster head election algorithm based on maximum weight for MANET", 3rd Int. Conf. on AdvancedComputing (ICoAC'11),315-320, 2011.
[11]. S. K. Gupta, N. jain and P. sinha, "Clustering Protocols in Wireless Sensor Networks: A Survey",International Journal of Applied Information Systems (IJAIS), Vol. 5, 41-50, 2013.
[12]. X. Liu, "A Survey on Clustering Routing Protocols in Wireless Sensor Networks", Sensors 2012, 11113-11153, 2012.
[13]. T. Hong, "An Improved Weighted Clustering Algorithm for Determination of Application Nodes in Heterogeneous Sensor Networks", Journal of Information Hiding and Multimedia Signal Processing, vol 2. 173-184, 2011.
[14]. E. A.Jarchlo and C. Bazlamaçcı, "Life Time Sensitive Weighted Clustering on Wireless Sensor Networks",International Conference on Sensor Networks SENSORNETS, 41-51, 2014.
[15]. P. Ding, J. Holliday, and A. Celik "Distributed energy-efficient hierarchical clustering for wireless sensor networks", First IEEE Int. Conf. on Distributed Computing in Sensor Systems Proceeding (DCOSS'05), 322-339, 2005.

BIOGRAPHIES

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