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A Study of Energy Efficient Clustering Protocols for Wireless Sensor Networks

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Abstract: WSN is usually motivated from the armed operation's gives improved outcome to in comparison with conventional wired network. In WSN nodes may be deployed in unmanned region. There are also a lot of fields of WSN application like farming, home study, location monitoring, structural health monitoring, heavy manufacturing monitoring, and security monitoring. In this paper, a survey on various clustering protocols has been done. From the survey, it has been concluded that none of the technique performs effectively in all fields. Although fuzzy based clustering has shown better results over the others but it has not yet improved for 3D wireless environment. Therefore the paper ends with the future scope to overcome these issues.

Keywords: Wsn, Clustering, Fuzzy Logic, Energy Consumption

1. INTRODUCTION

A wireless sensor network sometimes called **a** wireless sensor and actor network (WSAN) are spatially distributed autonomous sensor to *monitor* physical or environmental conditions, such as for example temperature , sound, pressures, etc. and to cooperatively pass their data through the network to a principal location. The more modern networks are bi-directional, also enabling *control* of sensor activity. The development of wireless sensor networks was motivated by military applications such as for example battlefield surveillance; today such networks are found in many industrial and consumer applications, such as for example industrial process monitoring and control, machine health monitoring, and so on.

The WSN is built of "nodes" – from a couple of to several hundreds or even thousands, where each node is connected to 1 (or sometimes several) sensors. Each such sensor network node has typically several parts: a radio transceiver with an internal antenna or connection to an external antenna, a microcontroller, a digital circuit for interfacing with the sensors and an energy source, usually a battery or an embedded form of harvesting. A sensor node might vary in dimensions from that of a shoebox down seriously to the size of a grain of dust, although functioning "motes" of genuine microscopic dimensions have yet to be created. The cost of sensor nodes is similarly variable, including a couple of to hundreds of dollars, with respect to the complexity of the in-patient sensor nodes. Size and cost constraints on sensor nodes bring about corresponding constraints on resources such as for example energy, memory, computational speed and communications bandwidth. The topology of the WSNs can vary from the simple star network to an advanced multi-hop network. The propagation technique between the hops of the network can be routing or flooding. A single node has the capacity to gather data from the region within its range. In order to own semantically meaningful information from the entire region, these nodes operate in a collaborative manner. Net-works made up of such nodes with sensing capability are called wireless sensor networks (WSNs). Desire to of early deployment was to use these sensors in a passive way for indoor applications.

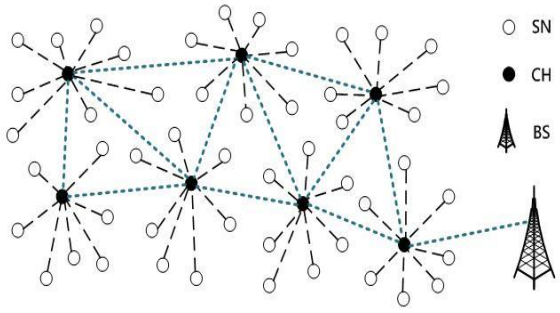

Figure 1: shows the a)base station and b) cluster heads and c)sensor nodes in a network[19]

These early nodes have the capacity to sense scalar data such as temperature, humidity, pressure and location of surrounding objects. Initially, these nodes have little computation capability and storage area and their only use is to transfer scalar data to the base station (sink). However, recently available sensor nodes have higher computation capability, higher storage area and better power solutions than their predecessors and their primary usage area shifts from indoor to outdoor applications. Sensor nodes with batteries that isn't rechargeable in nearly all of the cases. Energy schemes of the nodes have gained much interest among researchers. This topic has been studied for many years[1] and [2] are among the recent studies and lately the trend is towards energy-harvesting nodes [3]. However, readily avail-able commercial off-the-shelf nodes may not use this technology and the deployed area may not allow the usage of such available energy-harvesting methods. Because of all these reasons, decreasing energy consumption through energy-efficiency has been still one of the major goals [4]. In this respect, designing energy-efficient algorithms is a must to increase the duration of sensor node. Clustering can be viewed as the absolute most important unsupervised learning problem. So as every other problem of this type it relates to finding a structure in a collection of unlabeled data. A free definition of clustering could be the method of organizing objects into groups whose members are similar in a few ways. A cluster is therefore a collection of objects which are similar between them and are dissimilar to the objects belonging to we are able to show this with a simple graphical example. We easily identify the 4 clusters into that your data could be divided the similarity criterion is distance. Several objects belong to the exact same cluster if they are close according to certain distance. This study introduces a brand new clustering approach which is not only energy-efficient but additionally distribution-independent for wireless sensor networks (WSNs). Clustering is used as a way of efficient data gathering technique in terms of energy consumption. In clustered networks, each node transmits acquired data to a cluster-head that the nodes belong to. Following a cluster-head collects all the data from all member nodes, it transmits the data to the bottom station (sink) either in a compressed or uncompressed manner. Unequal clustering techniques generate clusters in smaller sizes when approaching the sink to be able to decrease intra-cluster relay. Along with the hotspots problem, the energy hole problem may also occur because of the changes in the node deployment locations. Although a number of previous studies have centered on energy-efficiency in clustering, to the best of our knowledge, none considers both problems in uniformly and non-uniformly distributed networks.

2. ENERGY EFFCIENT PROTOCOLS

There are several proposed clustering algorithms for WSNs. In the following paragraphs, key and discriminating top features of the widespread clustering algorithms are stated. To be able to help specify the important thing top features of our proposed algorithm, it's beneficial to conceive what other available proposed algorithms do for clustering

A. LEACH

LEACH is just a distributed algorithm which promotes local decisions to choose CHs [9]. It selects CHs predicated on probability model and then rotates CHs. This model is employed to be able to balance energy use of the nodes through the network lifetime; otherwise selected CHs would consume more energy when com-pared to member nodes. In LEACH, CHs perform data compression before transmitting data to the sink. However, LEACH is not an efficient algorithm with regards to the network lifetime since it does not think about the distribution of sensor nodes and the remaining energy on each node. We first consider that the threshold T(n) is modified to the following equation.

$$T(n) = \begin{cases} \dfrac{P}{1 - P \times \left(r \bmod \dfrac{1}{P}\right)} & \text{if } n \epsilon G \\ 0 & \text{otherwise} \end{cases}$$

Where p is the percentage of cluster heads over all nodes in the network r is the number of rounds of selection G and is the set of nodes that have not been selected as cluster heads in round 1/p. The node whose number is larger than the threshold will select itself as a cluster head and then broadcasts the message to its surround sensor nodes.

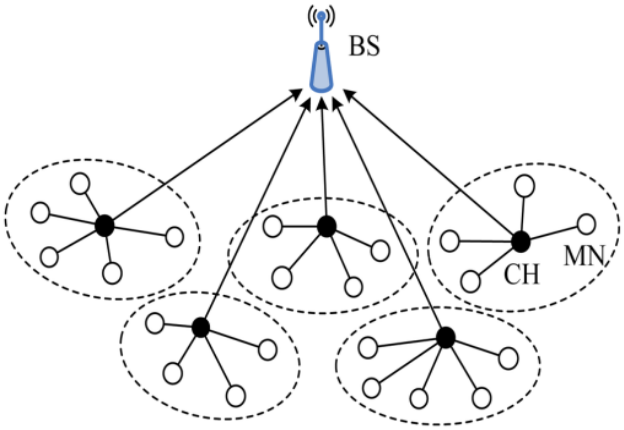

Figure 2.shows leach clustering [19]

B. Hybrid Energy-Efficient Distributed (HEED)

HEED protocol is made for multi-hop networks and node-equality is the principal assumption [10]. Two-phase parameter check is performed to choose CHs. In the very first phase, remaining energy of a node is useful for the probabilistic selection of the CHs. If a tie occurs in the very first phase, second-phase parameters such as node degree, distance to neighbors, and intra-cluster energy consumption are applied to break the tie in the selection process. However, HEED algorithm is suffering from the hotspots problem and causes unbalanced energy consumption due to the tendency to generate a lot more than expected number ofclusters [11]. Before a node starts executing HEED, it sets its probability of becoming a cluster head,*CHprob*, as follows:

$$CHprob = Cprob * \frac{Eresidual}{Emax}$$

Where Eresidual is the estimated current residual energy in the node and Emax is a reference maximum energy which is typically identical for all nodes. The CHprob value of a node however is not allowed to fall below a certain threshold.

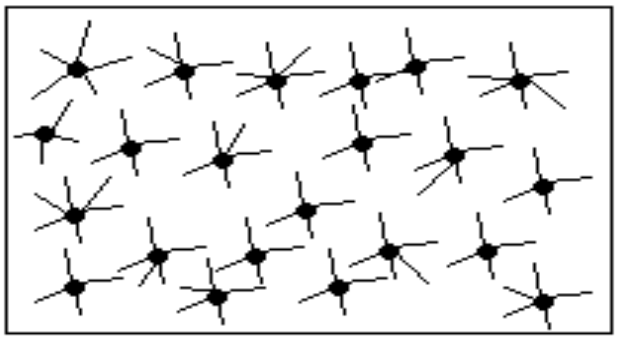

Fig 1: Topology of network after first level election.[19]

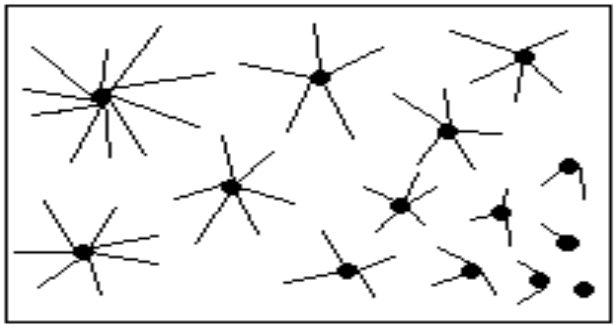

Fig 2: Topology of network after second level election completed. (Unequal sized clusters, smaller near base station).[19]

C. Energy Efficient Clustering Scheme (EECS)

EECS is introduced for periodical data gathering applications in WSNs [13]. It is a LEACH-like protocol such that it utilizes node residual energy in the selection of constant number of CHs, however, in the cluster formation phase load is balanced among CHs. It is a distributed algorithm and the experimental results show that it performs nearly35% more energy-efficient than LEACH. Since EECS accounts for single-hop communications, long-range transmissions generating directly from CHs to the sink can lead to much energy consumption, and hence it is not suitable and scalable for long-range or large networks [11].

$$\sum_{I=0}^{K+1} Ni = N + 1$$

Where Ni [1,N] note that for purpose of optimization the energy consumption and to obtain the solution we have allowed Ni , i=0,1……K+1 to be float number through in real network.

3. LITERATURE SURVEY

Xin, Guan et al. [1] presented a novel clustering technique for wireless sensor networks. During the phrase of cluster initialization, the sensed zone is divided into several virtual hexagons which it can avoid the overlapping nodes of circular cluster. Furthermore, they made some sub-circle in the formatted virtual hexagon base on the average distance between the common nodes and the cluster's center. Depending on the special factor's value, each node will form a cluster heads order list. The clustering technique adopts a new method for cluster head election, which can avoid the frequent election of cluster head. Simulation results demonstrate that their proposed algorithm is effective in prolonging the lifetime of networks.Yuan, Jinhui, and Hong Chen [2] proposed an optimized clustering technique based on spatial-correlation in wirelesssensor networks (WSN). It combines the advantages of clustering technique with spatial-correlation. It can avoid the impact of unexpected data on the results and get approximate results in a tolerant error by using similarity degree to construct clusters. Moreover, for only cluster-heads transmit data to sink node, it can reduce the messages sent in WSN a lot. It includes four parts: clusters construction, cluster-head election, clustering routing and clusters maintenance. Simulation results show that the approach is energy efficient and has lower average relative error than other approaches. Goli, Sepideh et al. [3] addressed clustering as an efficient way for routing. However, the available clustering algorithms do not efficiently consider the

geographical information of nodes in cluster-head election. This leads to uneven distribution of cluster-heads and unbalanced cluster sizes that brings about uneven energy dissipation in clusters. In this paper, an Efficient Distributed Cluster-head Election technique for Load balancing (EDCEL) is proposed. The main criterion of the algorithm, dispersal of cluster-heads, is achieved by increasing the Euclidian distance between cluster-heads. Simulation results show the effectiveness of this approach in terms of balancing intra-cluster energy dissipation and lifetime longevity. Veena, K. N., and BP Vijaya Kumar [4] proposed a method for clustering and their analysis to study the cluster formation, their behaviour with respect to the system parameters and applications requirement. The technique involves the adoption of computational intelligence to form clustering. They had used Nero-Fuzzy technique to obtain Dynamic clustering. The simulations are carried out to evaluate the performance of the proposed method with respect to different parameters of sensor node and applications requirement.Bhattacharjee, S., and Subhansu Bandyapadhyay [5] proposed a dynamic multi hop routing technique using residual energy based clustering algorithm to prolong node as well as network lifetime. Here, clusters are constructed using certain suitable parameters such as remaining energy of the nodes, its centrality, energy efficiency and cluster heads selection frequency Furthermore, after collecting all data within acluster, the cluster heads gradually enhance their transmission range till finding a high residual energy based adjacent cluster heads to forward the data to the base station. In this way the proposed method generates an energy efficient routing path from each sensor to base station to send the data. Simulation results show that their approach effectively conserves energy for cluster heads as well as cluster members and prolong their life time effectively. This proposed method also reduces number of clusters and thus improve the nodes life time significantly. Suroso, Dwi Joko et al. [6] proposed the new method of radio frequency (RF) fingerprint-based techniquefor indoor localization. The received signal strength indicator (RSSI) is used as database values which correspond to the location of the sensor nodes. Fuzzy C-Means (FCM) clustering algorithm is applied as the experiment data cluster method. FCM algorithm is deployed to cluster the obtained feature vectors into several classes corresponding to the different amount of RSSI values. The results show that FCM can cluster the target node in a group of the fingerprint database. The location of target node is arranged in various forms to validate the accuracy of the clustering technique. Euclidean distance is used as the parameter to compare the similarity between fingerprint database and the target location. The results show that the new method is simple and effective method to reduce the complexity and to support the low power and to reduce the time using in the fingerprint-based localization technique. Zytoune, Ouadoudi et al. [7] presented a new algorithm for cluster forming in wireless sensor networks based on the node residual energy compared to the network one and allowing a better partitioning the network area. The simulation results show that this algorithm allows network stability extension compared to the most known clustering algorithm. Thomas, Aby K., and R. Devanathan et al. [8] proposed a technique by which energy consumption can be reduced by introducing dynamic multilevel hierarchical clustering and where by enhancing the network lifetime. An energy consumption model is framed to make a better analysis of the system. A state transition pattern for the nodes is also allotted for the introduced nodes to make better use of the inherent energy of each node. Wang, Sheng-Shih et al. [9] proposed a clustering technique, called ELECT, to provide an energy efficient and reliable routing in wireless sensor networks. The ELECT considers node status and link condition, and introduces a clustering metric, called predicted transmission count (PTX), to evaluate the qualification of nodes for cluster heads and gateways. Each cluster head or gateway candidate depends on the PTX to derive a priority. The cluster head or gateway candidate with the highest priority will become the cluster head or gateway. Simulation results show that the proposed ELECT significantly outperforms the clustering technique using a random selection and considering only link quality and remaining energy in packet delivery ratio and energy consumption. Dutta, A. Raju et al. [10] discussed that sensor node in the heterogeneous network is more challenging and difficulties. In heterogeneous system, generally power consumption is more then homogeneous system. Which are valuable for increasing the overall network life, scalability of WSNs. Clustering sensor nodes is an effective and efficient technique for achieving all the requirement. In this paper, they studied the comprehensive theoretical aspects of the clustering problem to energy optimization in wireless sensor networks.Bhowmik, Shimul et al. [11] proposed Mean neighbor clustering algorithm that evenly distributes the nodes around the clusters and form well balanced clusters in the system. The proposed Mean neighbor clustering protocol uses the local neighborhood information to form balanced clusters in sensor networks. Varalakshmi, P. et al. [12] proposed an efficient fuzzy based Clustering technique to minimize the energy

consumption in WSNs. Adulyasas, Attapol et al. [13] proposed a clustering technique, included CH selection and rotation, using an event-driven data reporting during continuous data monitoring of ambient. SNs in this technique report only necessary data when data changes exceeding a given threshold. Therefore, clusters are created only upon specific places where such necessary data changes are happening. Furthermore, the clusters are operated as long as the ambient situation is changing. Once the situation becomes stable, the clusters will be reset and every sensor node in these clusters switch to sleep mode in order to conserve energy consumed by CHs and members. Results show that the network lifetime and stability is better than some existing protocols.Gupta, Itika, and A. K. Daniel et al. [14] proposed an efficient clustering algorithm with position based multihop approach to partition the network region into levels with increasing number of cluster heads at each level. The cluster head closer to base station have smaller in size because it forwards the data to base station using Round Robin Technique to make the network more efficient. The proposed protocol improves the performance in delay and energy consumption. The proposed approach is more scalable than the existing solution.Kannadhasan, S. et al. [15] proposed a graph theory based secure data aggregation which has a three phases. They assumed the transmitted power and sensing power of the nodes. First phase performs the clustering and cluster head election process. Second phase performs the each clusters are calculated the distance, Energy and also dependence. Third phase performs the shortest path calculation was transmitted the data to secured or not. Finally the aggregated data was transmitted from the cluster heads to the base station. Their proposed models are analysis the acknowledgement through the base stations. Barakkath Nisha et al. [16] proposed the relative correlation based clustering (RCC) technique with high data accuracy and low computational overhead. Identifying spatial, temporal correlation and attribute correlation is the first phase of the proposed algorithm. Tripathy, Asis Kumar, and Suchismita Chinara. et al. [17] proposed an authenticated
datatransmission technique for Clustered wirelesssensor net work (CWSN). The proposed scheme starts by assigning the identity, shared secret key and an encryption key to the sensor nodes by the base station (BS). Subsequently the sensor nodes are deployed in the hostile environments, due to the self healing nature of the sensors, they will form a network to transmit the data. The secured communicating protocol described in this paper guarantees that, when two sensor nodes are in communication, they must have gone through prior authentication and key pre-distribution process. Sert, Seyyit Alper et al. [18] introduced a new clustering approach which is not only energy-efficient but also distribution-independent for wireless sensor networks (WSNs). Clustering is used as a means of efficient data gathering technique in terms of energy consumption. In clustered networks, each node transmits acquired data to a cluster-head which the nodes belong to. After a cluster-head collects all the data from all member nodes, it transmits the data to the base station (sink) either in a compressed or uncompressed manner.

3. COMPARISON TABLE

Table 1 represents the comparison of the various techniques.

Table 1: Comparison of Various Techniques

REF	AUTHOR	YEAR	TECHNIQUES USED	FEATURES	LIMITATIONS
1.	Xin, Guan et al	2008	cluster head election	prolonging the lifetime of networks	The effect of 3D being ignored.
2.	Yuan, Jinhui, and Hong Chen	2009	Multilevel network clustering	energy efficient for immobile nodes in Wireless Sensor Network	The effect of energy efficiency in multiple sink being ignored.
3.	Goli, Sepideh et al	2010	Efficient Distributed Cluster-head Election technique (EDCEL)	energy dissipation and lifetime longevity	The multi-objective fuzzy clustering algorithm has the ability to address both hotspot and energy hole problem in station and evolving network.
4.	Veena, K. N., and BP Vijaya Kumar	2010	Nero-Fuzzy technique Nero-Fuzzy technique	to study the cluster formation	The effect of 3D being ignored.

5.	Bhattacharjee, S., and Subhansu Bandyapadhyay	2011	dynamic multi hop routing technique	improve the nodes life time significantly.	The effect of energy efficiency in multiple sink being ignored.
6.	Suroso, Dwi Joko et al	2011	Fuzzy C-Means (FCM) clustering	reduce the complexity and to support the low power	The multi-objective fuzzy clustering algorithm has the ability to address both hotspot and energy hole problem in station and evolving network.
7.	Zytoune, Ouadoudi et al	2011	routing techniques	better partitioning the network area	The effect of 3D being ignored.
8.	Thomas, Aby K., and R. Devanathan et al	2011	dynamic multilevel hierarchical clustering	inherent energy of each node	The effect of energy efficiency in multiple sink being ignored.
9.	Wang, Sheng-Shih et al	2012	ELECT technique	remaining energy in packet delivery ratio and energy consumption	The multi-objective fuzzy clustering algorithm has the ability to address both hotspot and energy hole problem in station and evolving network.
10.	Dutta, A. Raju et al	2012	Clustering techniques	energy optimization in wireless sensor networks	The effect of 3D being ignored.
11.	Bhowmik, Shimul et al	2012	Mean neighbor clustering	optimize the initial clustering process	The effect of energy efficiency in multiple sink being ignored.
12.	Varalakshmi, P. et al	2013	efficient fuzzy based Clustering	minimize the energy consumption in WSNs	The multi-objective fuzzy clustering algorithm has the ability to address both hotspot and energy hole problem in station and evolving network.
13.	Adulyasas, Attapol et al	2013	clustering technique, included CH selection	network lifetime and stability	The effect of 3D being ignored.
14.	Gupta, Itika, and A. K. Daniel et al	2013	Round Robin Technique	delay and energy consumption	The effect of energy efficiency in multiple sink being ignored.
15.	Kannadhasan, S. et al	2013	graph theory approaches	secure data aggregation	The multi-objective fuzzy clustering algorithm has the ability to address both hotspot and energy hole problem in station and evolving network.
16.	Barakkath Nisha et al	2014	relative correlation based clustering (RCC) technique	high level of detection rate (99.87%) in the top-line with near to the ground false alarm rate	The effect of 3D being ignored.
17.	Tripathy, Asis Kumar, and Suchismita	2014	data transmission technique	secured communication in the networks	The effect of energy efficiency in multiple sink being ignored.

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18.	Sert, Seyyit Alper et al	2015	"MOFCA: Multi-objective fuzzy clustering algorithm for wireless sensor networks."	estimating the lifetime of the WSNs and efficiency of protocols	The multi-objective fuzzy clustering algorithm has the ability to address both hotspot and energy hole problem in station and evolving network.

4. CONCLUSION AND FUTURE SCOPE

In this paper, a survey on various clustering techniques has been done . From the survey, it has been concluded that the effect of 3D being ignored in the literature. Moreover s in the real time the effect of energy efficiency in multiple sink being ignored. Also the multi-objective fuzzy clustering algorithm has the ability to address both hotspot and energy hole problem in station and evolving network. Therefore in near future, a new multi-objective fuzzy clustering algorithm can be proposed which has the ability to address both hotspot and energy hole problem.

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