ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2016

A Survey on Energy Optimization in WSN using Distributed Clustering Approach

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ABSTRACT: Recent advancement in technologies serving various smart applications has led to the expansion of wireless networks consisting of sensor equipped devices. The sensing devices in Wireless Sensor Networks (WSN) are randomly deployed across the large environmental regions to monitor the real-time occurrence of events. The sensor nodes coordinate and communicate the acquired data with other distant nodes upon sensing and assessment operations. Most of the energy of sensor nodes gets depleted in the data communication process. To reduce the overall energy consumption in the WSN clustering is widely used as an optimal approach.This paper presents a survey on recently adopted distributed clustering mechanisms for balancing the energy consumption and enhancing the lifespan of the WSN. The benefits and issues of each identified approaches are also emphasized.

KEYWORDS: Cluster, Cluster Head, Distributed clustering, Network lifetime, Wireless Sensor Network

I. INTRODUCTION

WSN consists of multiple sensor nodes that are placed across different remote locations in non-uniform manner. Sensor nodes are self-regulating in nature and are mainly deployed to gather consistent change in the actual phenomena such as pressure, distance, location, noise, temperature etc. The sensed information is disseminated to the end users for reporting the cause ongoing events so as to notify the need of generating preventive measures [1].

The major challenge in implementing WSN is the fair distribution of resources to provide a well-established, scalable and durable network setup. One of the crucial issue of WSN is the source of energy. The lifespan of a node in the network completely depends on the inbuilt power source i.e. battery. Since the size of sensor node is small, the capacity of battery is finite, increasing energy management issues. Also, the sensor nodes are place in an area unreachable by the end users, hence the cell cannot be easily renewed or recharged for its entire lifetime in the network [2].

For optimal functioning of the WSN effective utilization of system energy is required. Clustering of the sensor nodes has been identified as a promising approach to lessen the amount of energy being consumed in a WSN. Distinction of clustering mechanism is determined by topological arrangement of nodes either in centralized or distributed order.

Centralized approach involves the assignment of network parameters by the central Base Station (BS) for each node in the network. The central node controls and coordinates the functioning of entire network either periodically or randomly based on the pre-defined metrics [3]. It may result in degrading the network performance due to the limitation of single point of node failure.

II. DISTRIBUTED CLUSTERING

Distributed clustering, on the other hand, involves grouping of the sensor nodes into multiple non-uniform subgroups called clusters [4]. The nodes in these clusters transmits the captured data to the representative node i.e. the Cluster Head (CH). Then the CH forwards the aggregated data from its member nodes to the BS. The BS is either connected to the external network or to the end user where the gathered data is characteristically observed.

To conserve the scarce energy resource, data communication is allowed based on single hop and multi hop clustering. Single hop clustering involves the CH communicating with sensor nodes that are at most on hop distance to its neighbor in the cluster. Whereas in multi hop clustering the inter-cluster and intra-cluster communication of node is defined. Nodes in two or more clusters communicating with each other forms the inter cluster data transmission.

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In case of intra-cluster communication the CHs communicates directly with the base station. If the distance between CH and the BS is too large then it may result in exhaustion of the CH as much of the energy is wasted in transmitting the data directly to a distant BS. For this, multi hop intra-cluster communication is directed as solution in which the CH does not communicate directly with the BS located at much greater distance. Rather CH transmits the data through multiple hops to reach the BS.

Distributed clustering is mostly preferred for implementing a large-scale energy saving WSN.The next section discusses existing research work for enhancing energy consumption based on distributed network topology.

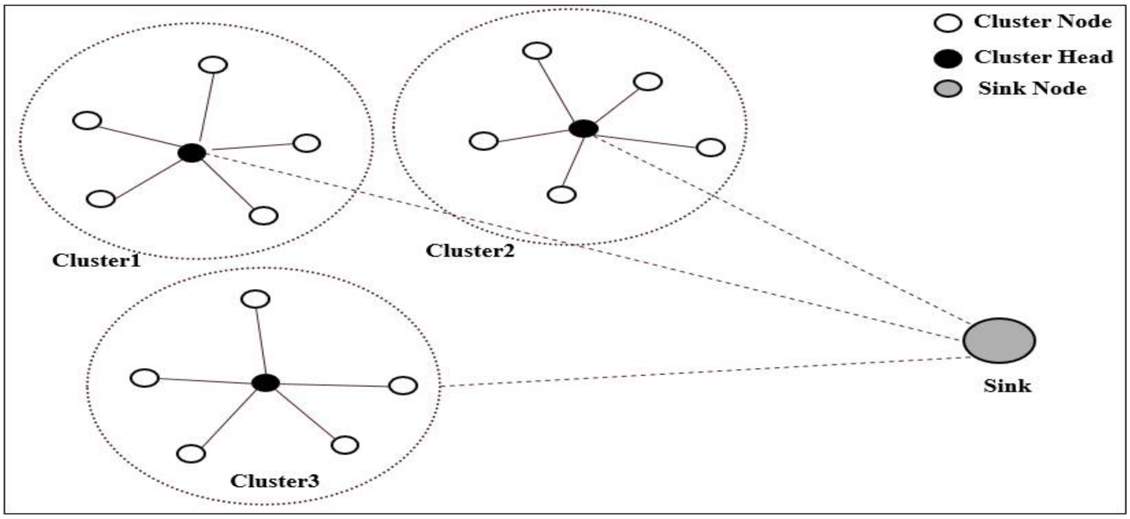

Figure 1: Distributed Clustering

III. LITERATURE SURVEY

For various applications and deployment structures many energy-efficient clustering protocols have been developed. Here we present a survey on various distributed clustering algorithms proposed by researchers for implementing energy adequate WSN.

Chirihane Gherbi et al. [5] proposed DEACP protocol. The idea is to fix the communication range for each node. Distance between the CH, weight of the nodes and residual energy are used as CH selection parameter. The node that covers maximum cluster radius is selected as CH. It results in low energy consumption as compared to PEGASIS and DEEAC protocol. Since range of each node is fixed more number of nodes positioned at long distance will remain un-clustered which reduces the throughput of the system.

Mariam Shaji et al. [6] EDDEEC algorithm. It introduces heterogeneous clustering in three levels. Distance of nodes from BS and average distance between CH and BS is used as a prime parameter for cluster formation. Probabilistic threshold values are used for CH selection. Although energy consumption is minimized on considering distance as a CH selection parameter, frequent change in CH may lead to more packet loss while data transmission which in turn may affect the energy consumption of the communicating sensor nodes.

R. U. Anitha et al. [9] proposed ECBR-MWSN algorithm. It defines an inter-cluster single hop communication protocol. The idea is to select a CH on the basis of minimum distance from BS, mobility of the node and residual energy as a clustering parameter. The protocol evaluates to be less energy consuming as compared to that of LEACH-M protocol.

MuhammadAmin Araghizadeh et al. [10] proposed DEED algorithm. It focusses on cluster formation on the basis of neighbour node discovery method. Membership scores are calculated based on the threshold values. CH uses control messages for selection of their own cluster members. The author compares the protocol with H-HEED protocol. It is found that more number of nodes are alive in DEED and thus more number of packets can be transmitted to the BS. It

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considers the selection of CH based on any developed algorithm. It does not guarantee the feasibility of CH selection criteria with the proposed cluster formation scheme.

LI Han et al. [11] proposed a MHEECA algorithm that uses probability of weight function for CH selection. Enables multi-hop communication for data transmission from CH to the BS on the basis of path computation. It proves to be better than LEACH protocol for balancing the energy consumption across the network.

Huiying Wei et al. [12] proposed ENCM algorithm that considers distance from the CH and the count of CH for distributed clustering. More number of nodes in a cluster that is near to the BS can reduce the energy consumed in data transmission process. Performance is high on comparing with EECS and LEACH algorithms.

Yichao Jin et al. [13] proposed a DERC algorithm, It deals with increasing the rate of clustering so that energy of all the nodes in the network remains almost equal. A node with average residual energy in a cluster is selected as the CH. Range of the CH for data communication is fixed. Energy consumption is minimum as compared to that of EEHC and EECS algorithms. But more clustering operations increases the network overhead as the ongoing communication between a node and CH may get disrupted.

Hung Quoc Ngo et al. [17] proposed a MEPA protocol that uses local message passing rules to find a minimal set of CHs. Improves the network performance as less number of clusters are formed. Results in improving the network lifespan when compared with HEED protocol. But frequent sending and receiving of messages increases the network overhead.

Clustering Approaches	CH Mobility	Connectivity of CH to BS	Clustering Properties	CH Selection Criteria
DEACP [5]	Mobile	Multi hop	Distance and Residual Energy	Hybrid clustering properties
EEDEEC [6]	Mobile	Single hop, Multi hop	Average Energy and Distance	Probabilistic
ECBR MWSN [9]	Mobile	Multi hop	Distance and Residual Energy	Clustering parameters
DEED [10]	Mobile	Single hop	Weight	-
MHEECA [11]	Static	Multi hop	Location and Residual Energy	Weighted probability
ECNM [12]	Static	Single Hop	Average Energy	Probabilistic
DERC [13]	Static	Single Hop	Distance and Residual Energy	Clustering Parameters
MEPA [17]	Mobile	Single Hop	Residual Energy	Message Passing

Table 1: Comparison of Distributed Clustering Protocols for WSN Algorithms

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IV. CONCLUSION AND FUTURE WORK

We discussed different distributed clustering techniques proposed by the researchers working in the field of energy-optimized WSNs. It is found that several parameters for preserving the energy resources have been taken into account. Most of the adopted method aimed at managing the network such that more number of nodes may remain alive until the existence of the network. Energy consumption in the WSN can be minimized by limiting the time duration up to which a node acts as a CH in each cluster. Rotation of the node serving as CH for the complete network lifespan can balance the depletion of energy of each node in the network.

Although different approaches have been proposed there is need to develop more scalable, robust and energy saving clustering protocols. Improved solutions for mobile WSNs based on single hop is an open area of research. Moreover, data dissemination can be extended as multi hop intra-cluster communication on the basis of varying clustering parameters such as degree of neighboring node, distance, hop count, residual energy, cost function etc.

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