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# Data aggregation techniques in WSN:Survey

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**Abstract**

Different data aggregation techniques require varying amounts of energy to process raw data. The choice of data aggregation method depends on the application requirements as well as the relative energy savings obtained by using this method. As various sensor nodes often detect common phenomena, there will be some redundancy in the data. Meanwhile many applications deploy more sensors than the exact requirement so as to accurately sense the target phenomena. In this paper, importance of data gathering is explained; various Hierarchical clustering approaches are compared.


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*Keywords: WSN; Data Gathering; Data aggregation; Clustered based protocols; Single Hop; Multi Hop;*

1. **INTRODUCTION:** Data aggregation, an essential paradigm for wireless routing in sensor networks aim to combine the data coming from different sources. Data aggregation can also eliminate redundancy, minimize the number of transmissions and thus save the energy. Data aggregation can also be performed via signal processing and called as data fusion. Data fusion combines some signals and removes the signal noise deploying some techniques and at the end, produces an accurate signal. The objective of data aggregation is to reduce the required communication at various levels, and so as to reduce the total energy consumption. When energy consumption for aggregation is less than energy consumption for raw data transmission to the upper level, data


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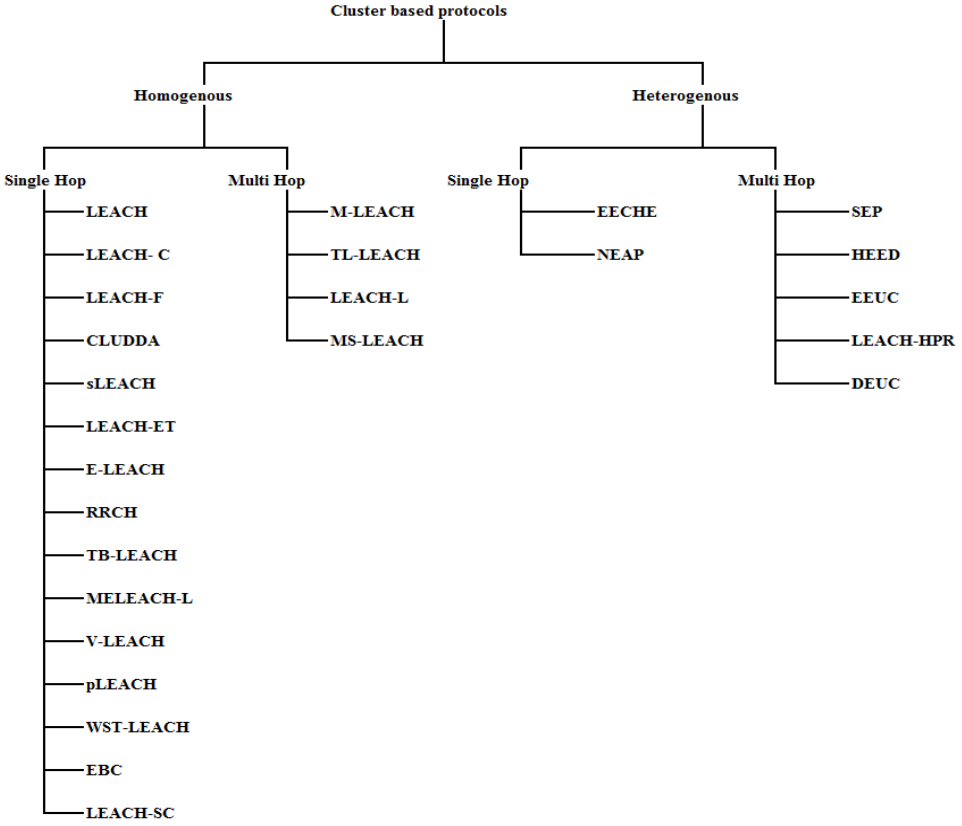
aggregation saves energy. Eliminating the redundancy as well as energy consumption is always an issue which aggregation protocol considered it. [16][3][2][23][13][21].Clustering – based aggregation protocol is approach in WSN for minimum communication and maximize overall network lifetime. Clustering reduces direct transmission to the base station by in network data aggregation as well as decreases energy consumption by reducing the transmitting distance. Better aggregation for large number of nodes is provided by Hierarchical clustering. [16][25][26][27].

## 1. Cluster Based protocols:




## 2.

### a) HOMOGENOUS SINGLE HOP:

**LEACH: (Low energy adaptive clustering Hierarchy):** .It protects from battery reduction and stability in nodes energy consumption. However it wastes energy during Cluster Head (CH) selection Phase& also uses a huge amount of energy when CH is at large distance from the sink. Moreover it doesn't guarantee of good CH distribution.

i) **LEACH-C-(Low energy adaptive clustering Hierarchy-Centralized):** In LEACH_C the base station initiates centralized algorithm to elect the CHs according to their location info. It forms better balanced Clusters. However it wastes energy to attain global information & not robust.

ii) **LEACH-F-(Fixed)**: LEACH-F is an effective clustering technique which is based on LEACH protocol wherein this clusters becomes fixed after its formation.It balances the energy consumption between sensors and also avoids setup overhead. Though it has Fixed Round time and it spoils energy and info due to CH death prior completing the round energy limitation.

iii) **CLUDDA-(clustered diffusion with dynamic data aggregation):** CLUDD which employs in-network processing to remove unneeded transmission and avoids flooding problem. It also achieves dynamic

data aggregation point. But it raises the delay time and needed huge memory storage.

iv) **sLEACH(Solar aware LEACH):** sLEACH): Solar power improves network lifetime It is used for both centralized and distributed CH selection algorithm.

v) **LEACH-ET (Energy Threshold):** Energy Threshold (ET) algorithm which calculates when to rotate rounds in LEACH algorithm. It conserves energy by reducing the time of round rotation However during control message transmitting consume a lot of energy due to transmitting a control messages. It does not support continuous monitoring.

vi) **E-LEACH (Energy):** E-LEACH protocol also has two phases and the first phase is divided into rounds. It conserves nodes residual energy but due to fixed time rounds energy is wasted.

vii) **RRCH (Round Robin Cluster Head Protocol):**The RRCH attain high energy efficiency by a single set-up process it is a single setup process and minimizes energy consumption yet it cause extra overhead.

viii) **TB-LEACH (Time Based Cluster head selection algorithm for LEACH):** TB-LEACH is a protocol which only changes the way of selecting CHs. it increases the lifetime of networks but is Weak in large scenarios.

ix) **MLEACH-L (More energy efficient LEACH):** MLEACH for Large-scale WSN protocol deciphers two issues of WSN i.e. channel assignment between neighbors within the same cluster, and the cooperation between CHs during calculating data. However it increases the setup phase and extra overhead

x) **V-LEACH (new version LEACH**):V-LEACH protocol better than the original LEACH protocol by choosing backup-CH which takes over the role of the CH if it dies. Yet it Increase Setup phase.

xi) **pLEACH(partition based LEACH):** It balances the wasted energy among sensor but with Increase Setup phase

xii) **WST-LEACH (weighted spanning Tree for LEACH):** Here the selection of CHs depends on three weighted considerations which optimizes transmission path which in turn reduce power dissipation resulting in increasing network lifetime.

xiii) **EBC (Energy Balanced Clustering):** it conserves the energy resources which are spent during unnecessary re-clustering stages. But it causes extra overhead.

xiv) **LEACH-SC (LEACH Selective cluster):**It Increase scalability yet gives extra overhead.[26][27]

**b) Homogenous Multi hop:**

i) **M-LEACH(Multi-hop Leach):**it is Suitable for large size network but it suffers from hotspot and limited scalability

ii) **TL-LEACH (Two Level LEACH): T**his algorithm reduces the energy consumption by allocating the energy load among the sensors in dense networks. However it is not suitable for densely deployed network.

iii) **LEACH-L:** it Balances the network load and reduces energy consumption. However has extra overhead

iv) **MS-LEACH (combines multihop and single hop):** It Reduces the energy consumption by amalgamating between single-hop and multi-hop transmission nodes. But has limited scalability and extra overhead.

**c) Heterogeneous Single Hop:**

i) **EECHE (energy efficient cluster head election protocol):** it is better than LEACH and SEP in terms of throughput and lifetime network and less latency but has limited scalability.

ii) **NEAP (Novel Energy adaptive protocol for heterogeneous wireless sensor networks):** It has improved reliability but has limited scalability and possibility of selecting CH which is at large distant from the sink.

**d) Heterogeneous Multi Hop protocols**

i) **SEP (Stable election protocol):** There is no need to collect information about node energy in every round bit it cannot be used for multilevel networks.

ii) **HEED (Hybrid energy efficient distributed clustering):** it stabilises power among nodes and control Overhead DEMERITS: cause a delay and limited scalability.

iii) **EEUC-Novel energy efficient clustering approach**: It prevents hotspot problem through uneven clusters but clusters are not balanced.

iv) **LEACH-HPR:** Here in CH select top stronger node as assistant node to stabilise energy consumption but it has extra overhead

v) **DEUC (Distance and energy based uneven clustering)**:it resolves hotspot problem but has extra overhead and clusters are not balanced. [26][27]

**3.** Related Work on data aggregation

| RESEARCHER | YEAR | FEATURES |
|---|---|---|
| RabindraBista et al [18] | Oct 2009 | RabindraBista et al [18] proposed an energy balanced and efficient data aggregation scheme for WSNs, called designated path (DP) scheme. DP scheme determined a set of paths and run them in round-robin fashion so that all the nodes can participate in the workload of gathering data and transferring the data to the sink. However dissipated energy was increased |
| Yasir Faheem and SaadiBoudjit [24] | 2010 | Yasir Faheem and SaadiBoudjit [24] proposed a distributed sink location update and a tree-based data gathering mechanism for mobile sink WSNs called SN-MPR. This mechanism deployed Multi-Point Relay (MPR) forwarding for sink location updates and queries. However there was a delay in data delivery. |
| Miao Zhao and Yuanyuan Yang [11] | Apr 2010 | Miao Zhao and Yuanyuan Yang [11] introduced a joint design of SDMA technique and multiple mobile collectors. In this DG-MS problem. is formalize |
| Babar Nazir and HalabiHasbullah [1] | Dec 2010 | Babar Nazir and Halabi Hasbullah [1] addressed hotspot problem and proposed Mobile Sink based Routing Protocol (MSRP) for Prolonging Network Lifetime in Clustered Wireless Sensor Network. It resulted in a balanced use of WSN energy and improves network life time. |
| Chi Yang et al [3] | 2011 | Chi Yang et al [3] developed an approach to suppress the in-network aggregate data based on the order compression techniques. |
| Miao Zhao et al [12] | Mar 2011 | Miao Zhao et al [12] presented a joint design of controlled mobility and SDMA technique for data gathering with a single SenCar and multiple SenCars, and formalized them as MDG-SDMA and MDG-MS problems. |
| Luca Mottola and Gian Pietro Picco [7] | Dec 2011 | Luca Mottola and Gian Pietro Picco [7] have proposed a routing protocol known as MUSTER for many-to-many communication. Results show that this protocol constructs near-optimal routing paths and doubles the WSN lifetime. |
| SongtaoGuo and Yuanyuan Yang [21] | 2012 | SongtaoGuo and YuanyuanYang [21] proposed a data gathering cost minimization (DaGCM) framework with concurrent data uploading, constrained by flow conservation, energy consumption, link capacity, compatibility among sensors and the bound on total sojourn time of the mobile collector at all anchor points. |

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|---|---|---|
| Basavaraj S. Mathapati et al [2] | Sept 2012 | Basavaraj S. Mathapati et al [2] developed a new energy efficient routing protocol called An Energy Efficient Reliable Routing Protocol for Wireless Sensor Networks (WSN) using data aggregation technique, Data aggregation is basically used to collect and aggregate data in an energy efficient manner so that network lifetime is improved. |
| Ning Jin et al [15] | Oct 2012 | Ning Jin et al [15] applied a slice based energy model, and divided the energy balanced data collection problem into inter- and intra-slice energy balance problems. |
| SongtaoGuo et al [22] | 2013 | SongtaoGuo et al[22] proposed a framework of joint Wireless Energy Replenishment and anchor-point based Mobile Data Gathering in WSNs by view of various sources of energy consumption and time-varying nature of energy replenishment.. |
| Xi Xu et al [23] | 2013 | Xi Xu et al [23] presented a data aggregation architecture model integrating a multi-resolution hierarchical structure with CS to further optimize the amount of data transmitted. |
| Liu Xiang et al. [8] | Dec 2013 | Liu Xiang et al. [8] have proposed a compressed data aggregation scheme that utilizes compressed sensing (CS) technique to achieve energy efficiency and recovery fidelity in WSNs with arbitrary topology. |
| Fei Yuan et al. [5] | April 2014 | Fei Yuan et al. [5] have proposed data density correlation degree based clustering method for data aggregation in WSN. |
| Dawei Gong and Yuanyuan Yang [4] | June 2014 | Dawei Gong and Yuanyuan Yang [4] constructed a data gathering tree based on a reliability model, scheduled data transmissions for the links on the tree and assigned transmitting power to each link accordingly. |
| MohammadrezaSoltani et al. [14] | June 2014 | MohammadrezaSoltani et al. [14] have proposed data fusion approach for resource efficiency in large WSN. Data fusion is used to determine a reduced node set to be active in the network, resulting in reduction of network resource consumptions. |
| Miao Zhao and Yuanyuan Yang [13] | Dec 2014 | Miao Zhao and Yuanyuan Yang [13] proposed to utilize mobility for joint energy replenishment and data gathering. A multi-functional mobile entity, called SenCar was employed, not only as a mobile data collector roaming over the field to gather data via short-range communication but also as an energy transporter that charges static sensors on its migration tour via wireless energy transmissions |
| SaeidMottaghia and Mohammad Reza Zahabi [19] | Feb 2015 | SaeidMottaghia and Mohammad Reza Zahabi [19] have proposed an algorithm that combines both the concepts of a mobile sink and rendezvous nodes to preserve the advantages of LEACH algorithm. |
| Shiliang Xiao et al. [20] | Mar 2015 | Shiliang Xiao et al. [20] have exploited the tradeoff between data quality and energy consumption in order to improve the data aggregation precision in case of heterogeneous per-node energy constraints. |

## 4. **CONCLUSION**:

Data Gathering helps to eliminate duplicate data transmission. Higher efficiency, network scalability and lower transmission of Hierarchical cluster based routing protocols make it most efficient routing protocols in WSN In this paper, we surveyed the Clustering –based aggregation protocol approach in WSN for minimum communication and maximize overall network lifetime. We examined recent proposed clustering protocols for WSNs and classified available schemes in categories of homogeneous, heterogeneous, single- and multi-hop. Survey results that, Firstly Data fusion is used to determine a reduced node set to be active in the network, resulting in reduction of network resource consumptions. Secondly, aggregation architecture model integrating a multi-resolution hierarchical structure with CS to further optimize the amount of data transmitted as well as Senscar helps in utilizing mobility for joint

energy replenishment and data gathering.

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