

Energy Efficient Data Aggregation Clustering Methods For Wireless Sensor Networks

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Abstract

A network in which numerous numbers of sensor nodes are deployed in a decentralized manner is known as wireless sensor network (WSN). In regions where humans cannot visit on their own, these wireless networks are deployed. These nodes are small in size and a deployed in such remote regions where regular visiting is not possible. So, a major concern when deploying these networks is to maintain the total amount of energy being consumed. The approach through which the overall network is partitioned among clusters and for individual cluster a head is selected is known as clustering. Many techniques of clustering are designed so far to improve lifetime of the network. In this paper, clustering methods which improve lifetime of the network are reviewed in terms of certain parameters.

Keywords

Clustering, WSN, Cluster head

Introduction

A network which is generated by gathering numerous small-sized and light-weighted sensors is known as a wireless sensor network [1]. The cost of these nodes is very less along with the less energy and number of processing capabilities. The WSN networks are deployed within various applications in order to gather important information from the surroundings. The various measures such as temperature, pressure and humid of the surroundings are calculated by the sensors deployed in those regions [2]. There are numerous applications such as in military areas, intelligent communications,

wildlife monitoring, observing critical infrastructures and so on in which these networks

have been deployed in order to observe surroundings and take appropriate actions. Within the WSN networks, there are two different types of sensor nodes [3]. They are the sensor node as well as the sink node. The data is sensed and gathered by the numerous sensor nodes present within these networks. Multiple hops are single hops can be used in order to transmit this data to sink node. With the help of Internet, this data can be utilized locally or globally by the sink [4]. The data can be sensed, collected, processed and then communicated to other nodes by each of the node present within the network. The environment is sensed by the sensing unit present within these nodes. The permutations of the sensed data are confined by the processing unit [5]. Further, the processed information is exchanged amongst the neighboring sensor nodes through the communication unit. In order to provide an energy source, a battery is present within the sensor nodes. However, there is very limited amount of power present within the batteries and the replacement of the batteries that have no energy left is impractical. Thus, within the WSN networks, the consumption of power in efficient manner is a major research area. In order to increase the lifetime of the network, numerous energy efficient techniques are presented by various researchers. WSN is a fundamental part of IoT [6]. The sensors nodes are deployed within the network sense the environmental conditions and collected all the required information. Further, the multi-hop communication has been utilized in order to transfer collected data to sink node. The comparison made between the collected information

obtained from distributed sensor nodes with the sink node in WSN network. As compared to the end devices, the more processing capability is present in these nodes [7].

The redundant data has been received by the relay node in case of the WSN applications based on periodic monitoring. In order to increase the network resource and node's power consumption, the sensed information which is co-related needs to be checked for its impact. Therefore, only the required data is forwarded by the relay node to the sink node instead of presence of redundant values that minimizes the energy dissipation [8]. There is enhancement in the utilization of resources for the transmission of data therefore named as the data aggregation. It is the technique or process in which data is gathered and integrated collected by the sensor nodes using aggregation function in the WSN.

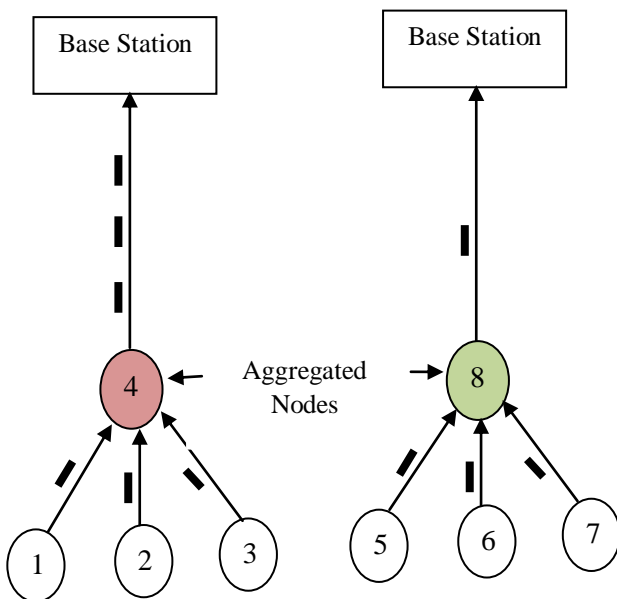


Fig. 1.1: With and Without Aggregation Data Models for IoT

Therefore, removal of data redundant transmission is the main objective of data aggregation that leads to improve in the lifetime of network. The defined correlated data packets must be aggregated together in order to make efficient data aggregation. The

processing of sensor node is shown how data is collected by it using the routing packets throughout the network [9].

The two models are shown in figure 1.1 in which one picture is with aggregation and other is without aggregation as shown above. The data is gathered from the environment by the sensor nodes using periodic sensor nodes such as 1, 2, 3 and 5, 6, 7 in these models after which this sensed data is send to upper nodes 4 and 8. Therefore, they are responsible for forwarding the data that is generated by the children nodes. However, the three data packets are forwarded to base station by node 4 in case of the non aggregation model. For the second model, the aggregator node 8 transmitted only one data packet to the base station. Therefore, there is reduction in the collected data before they are transferred to the sink using data aggregation method in this network.

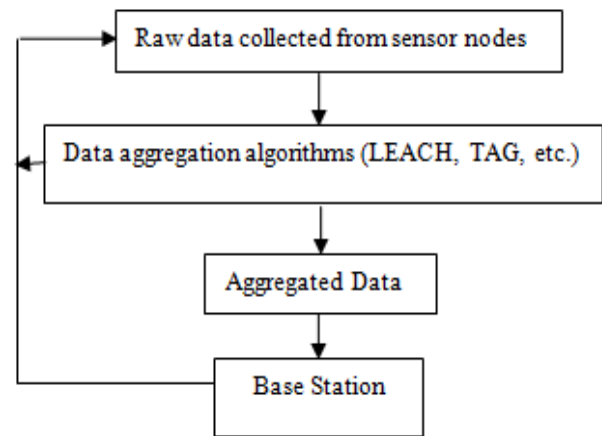


Fig. 1.2 Data Aggregation Algorithm Model

The architecture of data aggregation algorithm has shown in figure 1.2. The sensor node provides the sensed data to the algorithm and used some aggregation protocols to aggregate them such as LEACH, PEGASIS, TAG and many more [10]. in the WSN applications there are various aggregation functions that can be utilized for the processing.

Literature Review

Li et.al (2018) presented the major issue of security and the distributions of the data are considered as the major issue in this paper. They discussed the concept of distributing the n secrets to n clients in effective manner such as efficiently and securely [11]. They proposed an OT method which is widely utilized in various applications. In order to process anonymous communications and group signatures, the proposed method can also be applied when the crypto based protocols need to be designed. They proposed first algorithm in this paper for implementing the $n \times 1$ -out-of- n OT effectively. Therefore, they construct hidden permutation circuits. They investigated various aspects of protocol for the analysis of proposed method.

Qin et.al (2018) presented that in order to maintain the consistent transmission, it is required to use convergecast which has been widely utilized in industrial sensing and monitoring and also for the aggregation of information [12]. Therefore, for the process of communication, the essential role is played by the path duration in end-to-end delay. They proposed a probabilistic model in this paper for mobile convergecast and for the evaluation of duration time for the path capturing. This model utilizes some parameters. The outcomes concluded that proposed method has various applications in industrial networks and to provide feasible of end-to-end delays for implementing convergecast.

Yu et.al (2017) proposed a cluster-based data analysis framework k in this paper in which method of R-PCA has been utilized [13]. The highlighted problems can be presented with a solution here. Within the cluster head, the data is collected here in the process. The processing and computational burden on the sensor nodes has been minimized. The conducted research experiments show that proposed method provides effective and efficient results for the aggregation of sensor data provide high accuracy. It is also analyzed there is improvement in the detection of data outlier with accuracy.

Bhandari et.al (2017) proposed a new approach through which the problems faced by clustered WSNs related to queue delays and channel sensing can be removed. Few steps are applied on the two kinds of nodes such that the packets can be assigned accurately [14]. Prior sending the data to the cloud, they implemented new queues. They made comparison between the proposed method and the non-prioritized scheme using their results the proposed method is proved based on reliability and latency.

Shen et.al (2017) presented the emerging technology used in day to day life and various major areas where things are required to control through system, known as WSN. In this technology, heterogeneous communications protocols have been utilized for the implementation of this technology. They proposed a generic architecture for WSN in this paper over which various different devices can be operated easily [15]. Therefore, there are two DIY areas that are supported by this network. Therefore, they designed a centralized controller in order to connect these two DIYs that provide the interfaces for various steps.

Dong et.al (2017) presented the WSN (WSN) in this paper has been widely utilized nowadays due to its widespread applications in day to day life. The commonly used WSN applications are subscription and notification communication pattern with the help of which consumers are notified about their interested information or searched query. Therefore, for the information centric networking (ICN), they proposed a network aggregation and distribution in this paper [16]. This method is considered as best among others as for the future IoT deployment. There seen a reduction in the number of notifications due to this proposed method hence, the limited power issues in WSN devices is minimized by this method.

Karamitsios et.al (2017) presented there is vast development in the ecosystem of WSN due to the widespread applications, immensely growing

nowadays which attracted the attention of next generation information [17]. The main focus of this paper is on the health applications so that health of the patients can be controlled remotely from anywhere. Therefore, with the help of this device remote access is gained by the user or most importantly healthcare service providers using which they can monitor the patient by attaching the sensor nodes to their clothes or body. It is required to implement the proper protocol stacks in order to implement these sensor devices efficiently, backend services require and for the data aggregation. Therefore, for the different sensor data aggregation, they proposed different WSN protocol stacks in this paper. They evaluated the proposed method which showed effective outputs.

Ko et.al (2017) proposed a consistency-guaranteed and energy efficient sleep scheduling algorithm (CG-E2S2) in this paper [18]. They utilized the Markov decision process (MDP) in this paper for CG-E2S2 in order to determine number of

aggregated data and sleep duration. This also provides the data traffic in networks, data consistency and energy effacing in the WSN devices. Experiments were performed and concluded the effectiveness of the proposed method in terms of energy efficiency, data traffic volume, and data consistency.

Rao, et.al (2017) studied that the WSN devices send the data to the UEs, this data is aggregated with uplink data [19]. When the UEs have been utilized as relays, the WSN devices require less transmit energy as per done investigation. They studied the system in this paper and the association of WSN devices. It is identified that the minimum outage probability is given by the proposed method for the WSN devices. They also studied different aspects in this paper which helped in understanding the outcomes that could possibly be achieved after executing this newly designed method.

Table 1: Table of Comparison for different methods

Authors Names	Year	Description	Outcomes
RuinianLi, Carl Sturtivant, Jiguo Yu, and Xiuzhen Cheng	2018	They proposed an OT method which is widely utilized in various applications.	They investigated various aspects of the protocol for the analysis of proposed method.
Zhijing Qin, Di Wu, Zhu Xiao, Bin Fu, and Zhijin Qin	2018	They proposed a probabilistic model in this paper for mobile convergecast and for the evaluation of duration time for the path capturing.	The proposed method has various application in industrial networks and to provide feasible of end-to-end delays for implementing convergecast.
Tianqi Yu, Xianbin Wang, and Abdallah Shami	2017	A cluster-based data analysis framework k was proposed in this paper in which method of R-PCA has been utilized.	It was analyzed that proposed method provides effective and efficient results for the aggregation of sensor data provide high accuracy.
Sabin Bhandari, Shree Krishna Sharma, Xianbin Wang	2017	A new approach was proposed through which the problems faced by clustered WSNs related to queue delays and channel sensing can be removed.	They made comparison between the proposed method and the non-prioritized scheme using their results the effectiveness of proposed method is proved.
YulongShen, Tao Zhang, Yongzhi Wang, Hua Wang, and Xiaohong Jiang	2017	They proposed a generic architecture for WSN in this paper on the basis of internet architecture.	They designed a centralized controller in order to connect these two DIYs that provide the interfaces for the following important steps.

Lijun Dong, Guoqiang Wang	2017	For the information centric networking (ICN), they proposed INADS in this paper.	There seen a reduction in the number of notifications due to this proposed method hence, the limited power issues in WSN devices is minimized by this method.
KonstantinosKaramitsios, TheofanisOrphanoudakis	2017	The main focus of this paper is on the health applications so that health of the patients can be controlled remotely from anywhere.	They evaluated the proposed method using standard protocols for comparison.
HaneulKo, Jaewook Lee, and Sangheon Pack	2017	A consistency-guaranteed and energy efficient sleep scheduling algorithm (CG-E2S2) was proposed in this paper.	Experiments were performed and concluded the effectiveness of the proposed method.
ShilpaRao and Rajeev Shorey	2017	They studied the system in this paper and the association of WSN devices with the UEs.	On the basis of performed experiments, it is identified that the minimum outage probability is given by the proposed method for the WSN devices.

Conclusion

The research conducted in this paper summarized that the lifetime of nodes deployed in a network can be improved using clustering method. The most common and widely used protocol for this mechanism is known as LEACH. Clusters are generated by dividing the complete network and a head is elected individually for each of them. This research reviews and analyzes the different clustering techniques designed by researchers over the years and compares them to evaluate their performances. In future, a new energy efficient method will be designed to increase lifetime of the network.

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