A Review on Clustering Approaches for Wireless Sensor Network using Mobile Sink

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***Abstract* - Wireless Sensor Network (WSN) is a network which consists of different sensor nodes, where each sensor node has in-build storage and processing but its battery is not rechargeable. Main function of sensor nodes is to sense the environment, send the sensed data to the base station (BS), BS then further sends the data to the user through internet via gateway. There are several issues in WSN but the main issue is to conserve the energy of the nodes and to increase the lifetime of the network. So, the energy efficient clustering is adopted now days to conserve the energy and to overcome the hotspot problem. In clustering, sensor nodes are splitted into different clusters of equal and unequal sizes. This paper analyses the various works done in this field regarding efficient clustering approaches in WSN. Also concept of mobile sink is being discussed and all papers are analysed for their merits and demerits.**

***Keywords* - Wireless Sensor Network, Clustering, Mobile Sink, Optimal Routing**

I. INTRODUCTION

Clustering is one of the most popular unsupervised learning techniques (i.e. used for connecting the causative gap between input and output observation). Clustering is "the process of organizing objects into groups whose members are similar in some ways". Basically, clustering is to find the internal set of unlabeled information. In clustering, we organize the information in the form of packets or we can say into clusters. In most wireless sensor network (WSN) applications nowadays the entire network must have the ability to operate unattended in harsh environments in which pure human access and monitoring cannot be easily scheduled or efficiently managed or it's even not feasible at all. Based on this critical expectation, in many significant WSN applications the sensor nodes are often deployed randomly in the area of interest by relatively uncontrolled means (i.e., dropped by a helicopter) and they form a network in an ad hoc manner. Moreover, considering the entire area that has to be covered, the short duration of the battery energy of the sensors and the possibility of having damaged nodes during deployment, large populations of sensors are expected; it's a natural possibility that hundreds or even thousands of sensor nodes will be involved. In addition, sensors in such environments are energy constrained and their batteries usually cannot be recharged. Therefore, it's obvious that specialized energy-aware routing and data gathering protocols offering high scalability should be applied in order that network lifetime is preserved acceptably high in such environments. Naturally, grouping sensor nodes into clusters has been widely adopted by the research community to satisfy the above scalability objective and generally achieve high energy efficiency and prolong network lifetime in large-scale WSN environments. The corresponding hierarchical routing and data gathering protocols imply cluster-based organization of the sensor nodes in order that data fusion and aggregation are possible, thus leading to significant energy savings. In the hierarchical network structure each cluster has a leader, which is also called the cluster head (CH) and usually performs the special tasks referred above (fusion and aggregation), and several common sensor nodes (SN) as members. The cluster formation process eventually leads to a two-level hierarchy where the CH nodes form the higher level and the cluster-member nodes form the lower level. The sensor nodes periodically transmit their data to the corresponding CH nodes. The CH nodes aggregate the data (thus decreasing the total number of relayed packets) and transmit them to the base station (BS) either directly or through the intermediate communication with other CH nodes. However, because the CH nodes send all the time data to higher distances than the common (member) nodes, they naturally spend energy at higher rates. A common solution in order balance the energy consumption among all the network nodes is to periodically re-elect new CHs (thus rotating the CH role among all the nodes over time) in each cluster.

The BS is the data processing point for the data received from the sensor nodes, and where the data is accessed by the end user. It is generally considered fixed and at a far distance from the sensor nodes. The CH nodes actually act as gateways between the sensor nodes and the BS. The function of each CH, as already mentioned, is to perform common functions for all the nodes in the cluster, like aggregating the data before sending it to the BS. In some way, the CH is the sink for the cluster nodes, and the BS is the sink for the CHs. Moreover, this structure formed between the sensor nodes, the sink (CH), and the BS can be replicated as many times as it is needed, creating (if desired) multiple layers of the hierarchical WSN (multi-level cluster hierarchy).

Clustering parameter

There are some cluster parameter has been discussed in this section.

1. Number of clusters (cluster count). In most recent probabilistic and randomized clustering algorithms the CH election and formation process lead naturally to variable number of clusters. In some published approaches, however, the set of CHs are predetermined and thus the number of clusters is preset. The number of clusters is usually a critical parameter with regard to the efficiency of the total routing protocol.

2. Intracluster communication. In some initial clustering approaches the communication between a sensor and its designated CH is assumed to be direct (one-hop communication). However, multi-hop intracluster communication is often (nowadays) required, i.e., when the communication range of the sensor nodes is limited or the number of sensor nodes is very large and the number of CHs is bounded.
3. Nodes and CH mobility: If we assume stationary sensor nodes and stationary CHs we are normally led to stable clusters with facilitated intracluster and intercluster network management. On the other hand, if the CHs or the nodes themselves are assumed to be mobile, the cluster membership for each node should dynamically change, forcing clusters to evolve over time and probably need to be continuously maintained.
4. Nodes types and roles: In some proposed network models (i.e., heterogeneous environments) the CHs are assumed to be equipped with significantly more computation and communication resources than others. In most usual network models (i.e., homogeneous environments) all nodes have the same capabilities and just a subset of the deployed sensors isdesignated as CHs.
5. Cluster formation methodology: In most recent approaches, when CHs are just regular sensors nodes and time efficiency is a primary design criterion, clustering is being performed in a distributed manner without coordination. In few earlier approaches a centralized (or hybrid) approach is followed; one or more coordinator nodes are used to partition the whole network off-line and control the cluster membership.
6. Cluster-head selection: The leader nodes of the clusters (CHs) in some proposed algorithms (mainly for heterogeneous environments) can be preassigned. In most cases however (i.e., in homogeneous environments), the CHs are picked from the deployed set of nodes either in a probabilistic or completely random way or based on other more specific criteria (residual energy, connectivity etc.).
7. Algorithm complexity. In most recent algorithms the fast termination of the executed protocol is one of the primary design goals. Thus, the time complexity or convergence rate of most cluster formation procedures proposed nowadays is constant (or just dependent on the number of CHs or the number of hops). In some earlier protocols, however, the complexity time has been allowed to depend on the total number of sensors in the network, focusing in other criteria first.
8. Multiple levels. In several published approaches the concept of a multi-level cluster hierarchy is introduced to achieve even better energy distribution and total energy consumption (instead of using only one cluster level). The improvements offered by multi-level clustering are to be further studied, especially when we have very large networks and inter-CH communication efficiency is of high importance.
9. Overlapping. Several protocols give also high importance on the concept of node overlapping within different clusters (either for better routing efficiency or for faster cluster formation protocol execution or for other reasons). Most of the known protocols, however, still try to have minimum overlap only or do not support overlapping at all.

II. RELATED WORK

Lingyun Yuan, Xingchao Wang, Jianhou Gan et al. [1]proposed a data gathering algorithm based on mobile agent and emergent event-driven in cluster- based wireless sensor networks. In order to improve energy efficiency and decrease network delay in wireless sensor network applied to emergent event monitoring, a new data gathering algorithm based on mobile agent and event-driven is presented for cluster-based wireless sensor network. In this paper, the next hop in route planning for mobile agents is determined by the residual energy, the path loss and the stimulated intensity. The mobile agents can gather information by traversing all member nodes. The theory analysis and simulation results show that mobile-agent-based model has a better performance in energy consumption and network delay compared to C/S model. And mobile agent is more suitable for wireless sensor network than C/S model in data aggregation. Furthermore, DGMA will provide a more appropriate performance for wireless sensor network applied to a large scale emergent event monitoring.
R.Rajeshwari1, Mr. B. Prakash et al. [2] presented an Energy Efficient Cluster Based Approach in Wireless Sensor Networks Using Mobile Sink.Sensor networks are collection of sensor nodes which co-operatively send sensed data to base station. As sensor nodes are battery driven, an efficient utilization of power is essential in order to use networks for long duration hence it is needed to reduce data traffic inside sensor networks, reduce amount of data that need to send to base station. In cluster-based approach, whole network is divided into several clusters. Each cluster has a cluster-head which is selected among cluster members. Cluster heads do the role of aggregator which aggregate data received from cluster members locally. The proposed scheme is supposed to be an efficient datacompression technology is capable of shrinking the volume of the transmitted data or forwarded towards mobile sink.
Babar Nazir , Halabi Hasbullah et al. [3] presented Mobile Sink based Routing Protocol (MSRP) for Prolonging Network Lifetime in Clustered Wireless Sensor Network. In this paper, we address hotspot problem and purposed Mobile Sink based Routing Protocol (MSRP) for Prolonging Network Lifetime in Clustered Wireless Sensor Network. To evaluate the performance of the proposed strategy, intensive simulation is carried out using OMNet-4.0. Performance of the proposed strategy is compared to the static sink and multiple sinks strategies, using metrics such as energy per packet and throughput. The simulation results demonstrated that mobile sink strategy outperforms both static sink and multiple sink strategies in terms of energy per packet and throughput. It suggests that performance improvement can be made by using mobile sink in clustered WSN. Hence, MSRP is effective in prolonging the network lifetime as well as in improving throughput than static sink and multiple sink strategies.
Lanny Sitanayah, Cormac J. Sreenan, Kenneth N. Brown et al. [4] proposed Poster Emergency Response MAC Protocol (ER-MAC) for Wireless Sensor Networks. ER-MAC, a hybrid MAC protocol for emergency response wireless sensor networks. ER-MAC is designed as a hybrid of the TDMA and CSMA approaches. It adopts a TDMA approach to schedule collision-free slots. Nodes wake up for their scheduled slots, but otherwise sleep to conserve energy. When an emergency occurs, nodes that

participate in the emergency monitoring change their MAC behavior by allowing contention in TDMA slots. Simulations in ns-2 show that ER-MAC outperforms Z-MAC with higher delivery ratio, lower latency, and lower energy consumption.

Guoliang Xing, Member, IEEE, Tian Wang, Student Member, IEEE, Zhihui Xie, and Weijia Jia et al. [5] Rendezvous Planning in Wireless Sensor Networks with Mobile Elements has been proposed .In this paper, the rendezvous-based approach for utilizing MEs to collect sensor data under temporal constraints is discussed. Two rendezvous planning algorithms, RP-CP and RP-UG, are developed for the scenarios where MEs' paths are constrained on the data routing tree and MEs' paths are not constrained, respectively. In this work RDC protocol has been designed that facilitates reliable data transfers from the network to MEs. The simulations show that this approach significantly reduces network energy consumption and scale well with network density, ME speed, and the number of different deadlines. Moreover, RDC is robust to significant variance of ME speed.
Chaurasiya, Sandip K., Jaydeep Sen, Shrirupa Chaterjee, and Sipra D. Bit et al. [6] An energy-balanced lifetime enhancing clustering for WSN (EBLEC) has been suggested In this paper a clustering scheme in WSN is proposed where cluster heads are selected based on relative contribution of the nodes towards keeping the network alive for an extended period of time by balancing energy consumption. The contribution is measured not only based on residual energy of the nodes but also on their relative positions in the cluster. Performance of the scheme is measured in terms of network lifetime. Exhaustive simulation is performed varying different parameters that greatly influence network lifetime. Results in each case are compared with an existing clustering scheme that shows the present scheme outperforms the existing one.
Zhao, Huan, Songtao Guo, Xiaojian Wang, and Fei Wang et al [7] Energy-efficient Topology Control Algorithm for Maximizing Network Lifetime in Wireless Sensor Networks with Mobile Sink has been presented. In this paper, the problem of prolonging network lifetime in large-scale wireless sensor networks where a mobile sink gathers data periodically along the predefined path and each sensor node uploads its data to the mobile sink over a multi-hop communication path was studied. By using greedy policy and dynamic programming, we propose a heuristic topology control algorithm with time complexity $O(n(m + n \log n))$, where n and m are the number of nodes and edges in the network, respectively, and further discuss how to refine our algorithm to satisfy practical requirements such as distributed computing and transmission timeliness. Theoretical analysis and experimental results show that our algorithm is superior to several earlier algorithms for extending network lifetime.
Krishnan, A. Muthu, and P. Ganesh Kumar [8] An Effective Clustering Approach with Data Aggregation Using Multiple Mobile Sinks for Heterogeneous WSN has been presented in this paper. In the proposed algorithm, data gathering based on the clustering architecture with TDMA time slot helps to achieve an efficient data gathering approach. Further the data aggregation on the nodes within the cluster reduces the data traffic. The efficiency of the proposed model is evaluated based on number of data packets received, network lifetime and residual energy. The proposed algorithm achieves network lifetime increase with low energy utilization compared to other algorithm. The aim is not to highlight our self but give a solution for network researchers and motivate to work in a new direction.
Jose, Deepa V., and G. Sadashivappa et al. [9] proposed anovel scheme for energy enhancement in wireless sensor networks. In this paper a prologue to the two popular bioinspired optimization techniques ABC and PSO are given. The newly proposed strategy with sink mobility is compared with the ABC algorithm and the simulation results prove the efficacy of the proposed one in terms of average packet delay and the life time. It is necessary for a WSN to have less delay in packet delivery and the average energy should be high. These criteria are satisfied in the proposed algorithm. So this approach will be suited for real time applications where time delay plays a major role.

III. CONCLUSION AND FUTURE SCOPE

Various techniques related to efficiency improvement of wireless sensor network has been discussed in this paper. People have utilized clustering approaches for their pros and cons. Routing protocols for better communication has been discussed. Also the concept of mobile sink which is a novel concept has been discussed. The authors come to the conclusion that mobile sinks forms an interesting area of research which should be worked upon in future for performance improvement of networks in terms of delay, network lifetime, throughput etc.

IV. REFERENCES

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