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A Survey on Energy Efficient Optimal Routing in Wireless Sensor Networks

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ABSTRACT

In recent years, Wireless sensor networks (WSNs) have been emerged as an important research area due to its wide spread application in various domains such as military sensing and tracking, environment monitoring, patient monitoring, etc. WSN also have various advantages in gathering the data also with data transmission as well. Even though WSN has such advantages, there is certain drawback related to the energy consumption for data transmission over the network. Wireless sensor networks basically depend on the availability of nodes for transmission and if some dead nodes are available on the designated path of transmission, there will be delay in communication and also will affect the energy consumptions. Also, when a particular node is transmitting any data packet with high power, it may lead to interference which will affect the proper transmission of data and wastage of power as well. For power level reduction proper methodology has to be followed starting with the clustering and designing of routing protocols in WSNs. We intend to develop an enhanced clustering algorithm for initial clustering of sensor nodes for data transmission. Nodes will be clustered based on working attributes. Once nodes are clustered into different groups, transmission path will be assigned. An energy efficient optimal protocol will be designed in our approach for routing to improve the energy utilization by optimal power utilization. For optimization, we can employ multi objective optimization techniques which can enhance the optimal selection of power utilization. The proposed scheme will be then compared with some existing techniques to show the efficiency of the proposed approach.

Keywords : Wireless Sensor Network, Military Application, Cluster Head Transmission Power Self-Optimization

I. INTRODUCTION

Wireless Sensor Network(WSN) is a network which establishes maximum number of sensor nodes which are delopyed on an application domain to observe the physical substances in an objective territory, for instance, temperature observing condition, water level, checking weight, and medicinal services, and different military applications. For the most part sensor nodes are furnished with self-bolstered battery control through which they can perform satisfactory activities and correspondence among neighbouring nodes [1]. Expanding the lifetime of the Wireless Sensor systems, vitality preservation measures are basic for enhancing the execution of WSNs.

The best highlights of these WSNs incorporate little size, minimal effort, low calculation control, multifunctional (can perform detecting, information handling, steering, and so on.), and simple

correspondence inside short separations. In unattended unfriendly locales, these gadgets are deployed that make the sensors hard to recharge. Be that as it may, different research works and strategies are completed for safeguarding vitality in sensor nodes to expand the system lifetime [2]. Drawn out system lifetime, dependable information exchange, vitality preservation in sensor nodes and versatility are the fundamental necessities for WSN applications. Due to the few requirements in the sensor nodes, WSN is having different issues, for example, inclusion region, and network lifetime.

Clustering conventions can fathom a portion of those issues because of their versatility, vitality effectiveness, and information conveyance dependability [3,4]. In a cluster-based protocol, the networking time is isolated into rounds and each round is normally partitioned into three stages: Cluster Head (CH) choice, group development, and information transmission.

Data delivery reliability is viewed as a key prerequisite in WSNs [5]. With the end goal to understand this prerequisite, cluster-based protocols ought to embrace a multi-hop inter-cluster communication model as it is viewed as a more reasonable methodology due to the constrained transmission scope of the sensor nodes. A few connections quality-based cluster-based protocols proposed so far utilize the separation between two nodes as a metric of their connection's quality. Nonetheless, a few investigations have demonstrated that separation is not really connected with connection quality as it disregards the connection asymmetry normal for WSNs [6].

Aims and Objectives

The primary goal of this proposal is to develop an energy efficient and optimal routing protocol and algorithm for wireless sensor networks using transmission power self-optimization (TPSO) technique.

The following are the objectives:

1. To develop efficient transmission power self-optimization (TPSO) technique that uses Prims algorithm for creating MST and Genetic algorithm to find the optimal path in the network such that the lifetime of sensor nodes be increased.
2. To demonstrate the effectiveness of the TPSO technique, by showing that it can guarantee the targeted WSNs efficiency in different environment, while decreasing the energy necessary for data transmission between nodes.

II. LITERATURE REVIEW

Clustering strategies have been examined widely in the writing to enhance the efficiency of WSNs [7]. A substantial number of clustering based algorithms [8–11] dependent on heuristic strategies have been produced for WSNs. Among these LEACH [8] is an outstanding disseminated cluster-based algorithm in which the sensor nodes themselves as a CH with some likelihood. LEACH gives critical vitality sparing and drags out the lifetime of the system contrasted with static grouping and least transmission vitality (MTE) convention.

Hybrid energy-efficient distributed Clustering [12] is another dispersed cluster-based protocol that is an expansion of LEACH. Clustering is accomplished with an iterative methodology. CHs choice in this convention is principally founded on the leftover vitality of every node. To build vitality productivity and further delay network lifetime, an auxiliary clustering parameter considers intra-group "communication cost" is presented which can be a component of neighbor closeness or cluster density.

In [13] the authors have proposed an "energy efficient proficient heterogeneous cluster scheme" for WSNs (EEHC) to think about the effect of heterogeneity of node as far as their efficiency in clustered network.

They expected the situation where a level of the number of the populations in sensor nodes is outfitted with more vitality assets than the typical sensor hubs in the system. Three kinds of sensor nodes furnished with various efficiency levels were utilized. Nodes under first level are known as normal nodes, second level nodes are advanced node and third level nodes are super nodes. They demonstrated how the polling procedure of cluster heads ought to be adjusted suitably to manage heterogeneous nodes. The decision probabilities of CHs are weighted by the underlying efficiency of a node with respect to that of different nodes in the network.

A concentrated variant of (LEACH-C) is proposed in [14]. LEACH-C utilizes a Simulated Annealing (SA) way to deal with locate a foreordained number of CHs and to design the system into groups. The target work is characterized to limit the measure of vitality for the non-CH hubs to transmit their information to the CH, by limiting the aggregate total of squared separations between all the non-CH and the nearest CH.

Many researches examine about Fuzzy Logic (FL) how it very well may be connected on clustering with the goal that the energy consumption utilization will be limited. CHEF [15] considers two fuzzy parameters, for example, proximity distance and energy to elect the CH. Abhijeet Alkesh et al. [16] and Taheri et al. [17] has considered three fuzzy parameters, for example, vitality, fixation, and centrality to compute the opportunity to be the CH and expands the network life time. In F-MCHEL [18], CH is chosen by using fuzzy standards dependent on energy and proximity of distance. The node is having most extreme lingering energy among the CHs is chosen as a Master Cluster Head (MCH) and sends the collected information to the base station. F-MCHEL is an enhanced version of CHEF. The points of interest and disservices of these conventions are talked about in [23]. In [19]– [22] numerous conventions have been talked about dependent on fuzzy procedures.

[24] address about extending the network lifetime by using two approaches: (1) relay nodes to mitigate network geometric deficiencies and using particle swarm optimization algorithm to find optimal sink position to make network energy efficient. (2) EBTAWSN (Energy Balanced Transmission Algorithm for Wireless Sensor Networks). The proposed approach can sense element of computation and communication, it also acts as an administrator to measure, reach and observe events in transmission energy in specific environment. In each of the transmission rounds nodes with remaining energy higher than threshold relays addition nodes and this distribution of energy load improves lifetime.

In [25] the only solution to maximize the lifetime of networks is by the reduction in the number of nodes involved as communication participants. The data aggregation-based algorithms are played as most important power saving and reliable source of routing algorithms and this optimizes the communication via cluster head by the node degree considerations. Whatever algorithms help in minimizing the communication participants, the only way to maximize and improvise the life time of the network sensors are by the increase in sleeping nodes number with reduction in node ratio.

CH-selection is an optimization problem which is NPhard in nature as described in [26]. Classical optimization algorithms are inefficient with the increasing size of the network. Particle swarm optimization (PSO) is one of the efficient nature inspired algorithms which can be a better choice for such NP-hard problem due to its ease of implementation, high quality of solution, ability to escape from the local optima and quick convergence.

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III. RESEARCH METHODOLOGY

A transmission power self-optimization (TPSO) technique able to adjust individually the transmission power of each sensor node that composes the WSN, in order to guarantee a predefined efficiency for the network [27, 28]. The TPSO technique aims at guaranteeing the lowest possible transmission power while maintaining the connectivity of the WSN as well as the reliability of the transmitted data. Thus, the main idea behind the self-optimization algorithm is to assure the trade-off between WSNs energy efficiency and data transmission energy consumption. The TPSO technique runs on the application layer of the WSN. It adjusts the transmission power taking into consideration the entire WSNs Ef(efficiency). The technique uses the Ef associated to each slave node (SN) to compute the WSNs Ef. In more detail, the master node (MN) is responsible to compute the WSNs Ef as well as the Ef associated to each SN and to send the specific Ef to each SN. Finally, the SNs are in charge of adjusting their own transmission power levels based on their Ef by performing the TPSO algorithm

The top objective of this research is to maximise the lifetime of wireless sensor network and its nodes by rearranging connectivity between sensors. After implementing the TPSO algorithm, the process involves in three major processes namely construction of trees, Identifying critical tree using Prims algorithm and maximisation of lifetime of WSN using genetic algorithm through connecting networks. Prim's algorithm is a Greedy algorithm. It starts with an empty spanning tree.The idea is to maintain two sets of vertices. The first set contains the vertices already included in the MST, the other set contains the vertices not yet included. At every step, it considers all the edges that connect the two sets, and picks the minimum weight edge from these edges. After picking the edge, it moves the other endpoint of the edge to the set containing MST. Prim algorithm combines edge with least weight into spanning tree every time. So it can get spanning tree with least weight, namely MST. The algorithm allows finding the shortest path between the nodes, such that the data can be transferred from source node to destination node in less time and in an effective manner.

Construction of Tree: After the implementation, construction of tree processes will begin automatically. The base station sends to its neighbours the Identification parent and profounder. Every neighbour penetrates in the recursive schedule as well as identifies its neighbours; suppose any neighbour does not have profounder and origin of identification but it does not belong to the neighbour of base station, then neighbour penetrates in a schedule.

Identify the critical tree: When the tree's construction is completed; next processes begin naturally for identifying the critical tree that denotes a minimum ST (spanning tree) by adopting a greedy algorithm such as Prim's algorithm. The advantages of using Prim's algorithm are that the algorithm is relatively simpler and this algorithm is considerably faster in the limit when there exists a dense graph with more number of edges than vertices. The following is the pseudocode of prims algorithm.

In summary the Prim's algorithm operates in the following manner:

- Choose any starting vertex.
- Look at all edges connecting to the vertex and choose the one with the lowest weight and add this to the tree.
- Look at all edges connected to the tree that do not have both vertices in the tree.

- Choose the one with the lowest weight and add it to the tree.
- Repeat step 2 until all vertices are in the tree.

Finally, Genetic Algorithm is applied in such a way that it increases the sensor nodes lifetime and networks lifetime. Genetic Algorithms are heuristic search algorithms based on the mechanism of biological evolution. Diversity in biological evolution is the variation of chromosomes between individual organisms [29]–[31]. This chromosome variation will affect the rate of reproduction and the level of the organism's ability to stay alive. The Genetic Algorithm uses the principle of finding neighborhood solutions based on natural selection and natural genetic mechanisms that can be used to solve optimization problems such as the Minimum Spanning Tree problem [32]–[34]. In the Genetic Algorithm, solving the Minimum Spanning Tree problem is almost the same as the solution to other optimization problems. The only difference is the chromosome coding process (encoding), weight calculation (decoding) and recombination or crossover. In addition to the case of the Minimum Spanning Tree, another step is added, namely the process of modifying the degree to check the presence of a circuit or not. The whole process will be experimented with the network of different size so that the performance of the proposed technique can be found.

IV. COMPARISONS

This research would help to create a WSN which would increase the nodes lifetime. Further, also we propose a methodology to find the optimal path between the nodes which also consequently helps to develop an enhanced clustering based approach in Wireless Sensor Networks with the aid of energy efficient optimal routing algorithm.

Sr. No	Title	Method	Limitation	Scalability	Reliability	Throughput
1	An Enhanced PSO-Based Clustering Energy Optimization Algorithm for Wireless Sensor Network	Enhanced PSO-Based Clustering Energy Optimization (EPSO-CEO) algorithm for WSNs using PSO in which clustering and clustering head selection are done by using Particle Swarm Optimization (PSO) algorithm with respect to minimizing the power consumption in WSN.	Delay in data collection and transmission. Network lifetime	No	Yes	Yes

2	Energy-Efficient Communication Protocol for Wireless Microsensor Networks	LEACH (Low-Energy Adaptive Clustering Hierarchy), a clustering-based protocol that utilizes randomized rotation of local cluster base stations (cluster-heads) to evenly distribute the energy load among the sensors in the network.	uneven distribution of Clusters, LEACH does not give any idea about the number of cluster heads in the network, Death of Cluster head: the cluster will become useless because the data gathered by the cluster nodes would never reach its destination i.e. Base Station	Yes	yes	Yes
3	A hybrid, energy-efficient, distributed clustering approach for ad hoc sensor networks.	HEED (Hybrid Energy-Efficient Distributed clustering), that periodically selects cluster heads according to a hybrid of the node residual energy and a secondary parameter, such as node proximity to its neighbors or node degree	No multi-level hierarchies	Yes	No	No
4	EEHC: Energy efficient heterogeneous clustered scheme for wireless sensor networks	an energy efficient heterogeneous clustered scheme for wireless sensor networks based on weighted election probabilities of each node to become a cluster head according to the residual energy in each node.	Multi-level hierarchy and network lifetime	No	Yes	Yes

5	An energy-aware distributed clustering protocol in wireless sensor networks using fuzzy logic	an energy-aware distributed dynamic clustering protocol (ECPF) which applies three techniques: (1) non-probabilistic cluster head (CH) elections, (2) fuzzy logic, and (3) on demand clustering	QoS and network coverage	No	Yes	Yes
6	MAXIMIZING LIFETIME FOR WIRELESS SENSOR NETWORKS USING SWARM OPTIMIZATION AND ENERGY-BALANCED NODES	Energy balanced algorithm and PSO	Network coverage	Yes	No	Yes
7	Evaluating a transmission power self-optimization technique for WSN in EMI environments	TPSO	Network lifetime	No	Yes	Yes

V. CONCLUSION

In wireless sensor networks, routing is attracted lot of communication in past decade years and represents unique data communication and routing challenging in ad hoc networks. In this related work, relates to define different authors opinion regarding routing and energy efficiency concerns in wireless communication.

Further improvement of this research, different advanced routing approaches considered to describe network efficiency and other simulation parameters for wireless sensor network communications.

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