A Survey on Various Techniques used for Enhancing Wireless Sensor Network (WSN) Lifetime

1K.Nithyadevi, 2S.RadhaPriya
1M.Phil Research Scholar, 2Assistant Professor
Department of Information Technology
Government Arts College
Coimbatore 641018

Abstract: **Improving lifetime of Wireless Sensor Network is the most critical problem. The major cause of this problem is the limited energy resources. In WSN, sensor nodes are randomly located with battery power. These sensor nodes transmit the information through the network by monitoring, detecting and analyzing the physical phenomenon. While transmitting the information, the energy give up by each node gets increases. So it is required to minimize the energy consumption of nodes which probably maximizes the network lifetime. There were various techniques developed for extending the network lifetime. This paper provides detailed information about those techniques.**

INTRODUCTION

Wireless Sensor Network (WSN) consists of spatially distributed sensors to monitor physical or environmental conditions. Commonly monitored parameters are temperature, humidity, pressure, wind direction and speed, illumination intensity. Sensor nodes present in the network are small, lightweight and portable. Each and every sensor nodes has transducer, microcomputer, and transceiver and power source. Electrical signals are generated by transducers based on sensed physical effects and phenomena. The microcomputer processes and stores the Sensor output. The transceiver receives commands from a central computer and transmits data to that computer. The power for each sensor node is derived from a battery. While transmitting the information, the energy give up by each node gets increases which leads to quick death of network. So, the methods that balance or reduce the energy consumption should be used for enhancing the network lifetime. There were various techniques developed for this purpose.

Some of the techniques that improve the network lifetime are using relay nodes for data transmission, clustering techniques, Fuzzy Logic-Based Clustering Algorithm. When transmitting a data a destination node, a source node can reduce its transmission power by transmitting signal to relay nodes that are located closer to the source node. These relay nodes then relay the received signal to the receiver using their own battery power. In sensor networks, the use of relay nodes has been proposed for maximizing the network lifetime, energy-efficient data gathering, load-balanced data gathering as well as making the network fault tolerant. Another way to improve network lifetime is clustering. In WSN, sensor nodes are clustered to gather information more efficiently in terms of energy consumption. Each cluster member transmits acquired data to a cluster-head which the nodes belong to. After a cluster-head collects all the data from member nodes, it transmits the data to the base station (sink) in aggregated manner. Cluster-heads close to the sink tend to die earlier because of more energy consumption. Fuzzy Logic-Based Clustering Algorithm is then developed which selects super cluster head (SCH) is elected among the CHs who can only send the information to the mobile BS by choosing suitable fuzzy descriptors, such as remaining battery power, mobility of BS, and centrality of the clusters. Fuzzy inference engine (Mamdani's rule) is used to select SCH.

LITERATURE SURVEY

Xiang Min et al [2010] designed an energy efficient clustering algorithm based on analytical clustering model with one-hop distance and clustering angle. Clustering algorithm reduces the total energy consumption with optimum parameters. By reducing the energy consumption between inter-cluster and intra-cluster, optimum one-hop distance and clustering angle are derived. Here, local control centre consists of the continuous working mechanism of each cluster head and the optimum continuous working times of each cluster head can be obtained through the optimum one-hop distance and the clustering angle. This algorithm effectively reduced the energy consumption and improved the system lifetime.

Yi-hua Zhu et al [2010] proposed Energy-efficient Routing Algorithm to Prolong Lifetime (ERAPL) for improving network lifetime with efficient expends of energy. In this algorithm, data gathering sequence (DGS) is constructed for avoiding mutual transmission and loop transmission among nodes.

Mathematical programming model is then presented in which minimal remaining energy of nodes and total energy consumption is included. Genetic algorithm is used for finding the optimal solutions for all the nodes to distribute packets to their respective neighboring nodes. This approach improves the network lifetime by using both minimal remaining energy and total energy consumption. But for further enhancement of network lifetime, some overhead are needed to exchange messages between the sink and the nodes. Chia-Pang Chen et al [2010] proposed a hybrid genetic algorithm for enhancing the network lifetime of wireless sensor networks. This hybrid algorithm uses binary genetic algorithm with a fitness-improving local-search strategy to overcome the coverage problem in disjoint set covers (DSCs). The Binary genetic representation denotes the status of every sensor node and local-search strategy maximizes the fitness of each individual. A large number of DSCs can be identified using a hybrid genetic algorithm. All targets in the network can be monitored by every covers by periodically switching disjoint set covers. This algorithm improves both sensing coverage and network lifetime in an efficient manner.

Chuan-Kang Ting & Chien-Chih Liao [2010] proposed a memetic algorithm (MA) to solve K-COVER problem during enhancement of WSN. The memetic algorithm uses the Darwinian evolutionary scheme and Lamarckian local enhancement to select for optimal solution in global exploration and local exploitation. MA incorporates genetic algorithm for accurate selection of optimal solution. This algorithm does not consider the connectivity and coverage.

Ahmed E.A.A. Abdulla et al [2012] developed a hybrid approach which combines flat multi-hop routing and hierarchical multihop routing strategies. Flat multi-hop routing is used for reducing the total power consumption in the network. This is achieved by rendering uniform power consumption over individual nodes at the same time. Low-Energy Adaptive Clustering Hierarchy (LEACH) algorithm which is a Hierarchical multihop routing algorithm reduces the amount of traffic by using data compression. These two algorithms are combined to solve the network isolation problem. Thus, network lifetime is increased by solving such hotspot problem.

Behnam Behdani et al [2012] discussed about the Mobile Sink Model (MSM) and queue-based Delay Tolerance-MSM. MSM does not consider the delay in packet forwarding. DT-MSM considers the delay in transmission. Both these models faced the issues in column generation algorithm. Dijkstra's algorithm is used in this approach to solve the problem of column generation algorithm. After this, decomposition algorithm is applied to improve the network lifetime.

Fabian Castaño et al [2013] developed column generation approach with coverage and connectivity. This approach uses GRASP for full coverage of the targets and uses Variable neighborhood search (VNS) for covering a fraction of the target in the network. Then multiphase framework is developed combining these two approaches is built by sequentially using these two heuristics at each iteration of the column generation algorithm.

F. Castano et al [2013] proposed a hybrid Column Generation-GRASP approach to extend the WSN lifetime. This approach is applied for networks with single and multiple sinks. This approach first uses the GRASP approach to find profitable covers. Then uses the Greedy randomized construction which consists of restricted candidate list of nodes. Then local search phase uses a remove neighborhood to check for useless sensors that are not required. Then, a remove-insert neighborhood is considered to exchange one active sensor by an inactive sensor with lower cost that keeps the feasibility of the cover. But it does not consider the distance between sensors and targets which also influence the network lifetime.

Jiguo Yu et al [2013] proposed connected k-coverage working sets construction (CWSC) algorithm in WSN. This algorithm combines k-coverage and connectivity and it is based on the Euclidean distance to k-cover the sensing region by reducing the number of active sensors. CSWC reduce the overlap area of the sensing areas of two sensor nodes. CWSC also provides different coverage degrees requested by applications, which increases the flexibility of the network. This algorithm guarantees network connectivity and coverage.

Pengfei Zhang et al [2013] enhanced the lifetime of static clustering WSN using Clustering methods and energy-harvesting techniques. Energy Harvesting (EH) nodes in the network serves as relay nodes for cluster heads (CH). Cluster head selection algorithm is applied to choose CH in the cluster network. The selected CHs either aggregate or forward data directly to BS through dedicated relay nodes with energy harvesting (EH) capabilities. This approach can easily found the optimal or suboptimal solutions which are then used for designing various centralized and distributed clustering scheme.

Femi A. Aderohunmu et al [2013] proposed an Application-specific Forecasting Algorithm for

sensed data which saves packet transmission in the network. Author uses Naïve model to forecasts all the future values, fixed-Weighted Moving Average (WMA) to assign weights for prediction, Least-Mean-Square (LMS) performs prediction on time series data and ARIMA model for data reduction. Among these models, naïve model is robust and used for enhancing network lifetime.

Subir Halder & Sipra Das Bit [2014] developed a location-wise pre-determined heterogeneous node deployment strategy for improving network lifetime. The proposed strategy predetermines the number of nodes and exact locations of nodes within the area. First, the conditions for improving network lifetime are analysed. Based on the result of analysis, energy balancing principle is then derived to achieve targets in the network. Proposed node deployment scheme uses heterogeneous nodes and achieves energy balancing to a greater extent.
Bilal Abu Bakr & Leszek T. Lilien [2014] proposed the LEACH-SM protocol for extending network Lifetime. This algorithm first selects the optimal spare nodes using Decentralized Energy efficient Spare Selection Technique (DESST), then observes the energy-saving management of spare nodes after WSN deployment and finally calculates the lifetime of WSN. This algorithm minimizes the transmission of redundant data to cluster heads which efficiently improves the network lifetime.

Tarachand Amgoth & Prasanta K. Jana [2014] proposed the Energy-aware routing algorithm for WSN. This algorithm consists of clustering and routing phase. In clustering phase, sensor nodes are grouped into clusters by sending cluster join message through the network. In the routing phase, data are routed to the sink using directed virtual backbone (DVB). This algorithm proved that for better energy consumption, CHs should take part in data routing process and at the same time their relaying load is balanced with respect their residual energy. But this approach does not consider the dynamic scenario and fault tolerant factor.

K. Suganthi et al [2015] proposed a fault-tolerant virtual backbone tree (FTVBT) algorithm to enhance the lifetime. This algorithm is used to construct a virtual backbone tree. Constructing the backbone involves selecting tree nodes and each sensor node is associated with at least one tree node. Here, the system comprises a sink node and sensor nodes, which are classified as tree and non-tree nodes. The sink node broadcasts request packets and the nodes that receives request packets calculate their energy, the distance between the node and the node that sent the request packet and they identify the upstream link. The nodes that satisfy the threshold criteria become tree nodes. This algorithm also found solutions to hotspot problem and increases the network lifetime.

Songtao Guo et al [2015] developed a tree-based heuristic topology control algorithm called Minimum Load Set (MLS) algorithm. The parent node of each sensor node is found by MLS algorithm which grows a tree from fictitious root node. Then edges are added to the growing tree for reducing the maximum load of the current node and other nodes. The most optimal edge from each iteration can be selected by using load set concept. The reduction in heavier loads of nodes can improve the lifetime of all nodes present in the network. But this algorithm is applied only on local information.

Fateh boutekkouk et al [2015] proposed a hybrid approach to extend the life time of heterogeneous wireless sensor networks. This approach combines between the clustering and the chain approaches. The optimal cluster in the network is identified by using firefly algorithm and best chain in each cluster is found by simulated annealing algorithm. These algorithms improve the life time of heterogeneous WSNs with fixed base station by reducing the communication energy consumption.

N R Wankhade & D N Choudhari [2016] proposed Modified Election Based Protocol (MEBP) which uses path information for improving lifetime of the network. First, MEBP algorithm used the decision of selecting cluster heads by the sink. The decision is based on associated additional energy and residual energy at each node. Congested nodes present in the network are identified by MEBP algorithm and transmission path through those nodes is completely neglected. Now Selected cluster head chooses the shortest path among various paths to reach the sink by using obtained congested link. This kind of operations is useful for balancing the energy and in improving network lifetime.

Md Azharuddin & Prasanta K. Jana [2016] developed Particle swarm optimization scheme to solve hot spot problem caused by multi-hop communication in WSN. This scheme consists of routing and clustering algorithms. In the routing phase, traffic load over the cluster heads (CHs) is evenly distributed and in the clustering phase, CHs with fast Energy exhaustion is taken into consideration. Distributed scheme is then developed to prevent the CHs from their quick death. Prevention of such CHs may useful for enhancing network lifetime by overcoming the hot spot problem.

Padmalaya Nayak & Anurag Devulapalli [2016] proposed an approach in which the lifetime of the

WSN network was enhanced by using Fuzzy Logic-Based Clustering Algorithm. This algorithm uses Mamdani's rule by which Super Cluster Head (SCH) was elected among the CHs who can only send the information to the mobile BS based on fuzzy descriptors, such as remaining battery power, mobility of BS, and centrality of the clusters. The idea of sink mobility along with the fuzzy logic increases the network life time dramatically.

CONCLUSION

There were various algorithms developed for extending the network lifetime by reducing the energy consumption. Among them clustering algorithm provides efficient result by selecting appropriate CH to forward data to the sink node. Clustering algorithm with fuzzy logic can also improve the lifetime of WSN.

REFERENCES

1. Min, X., Wei-Ren, S., Chang-Jiang, J., & Ying, Z. (2010). Energy efficient clustering algorithm for maximizing lifetime of wireless sensor networks. *AEU-International Journal of Electronics and Communications*, *64*(4), 289-298.
2. Zhu, Y. H., Wu, W. D., Pan, J., & Tang, Y. P. (2010). An energy-efficient data gathering algorithm to prolong lifetime of wireless sensor networks. *Computer Communications*, *33*(5), 639-647.
3. Chen, C. P., Chuang, C. L., Lin, T. S., Lee, C. Y., & Jiang, J. A. (2010). A coverage-guaranteed algorithm to improve network lifetime of wireless sensor networks. *Procedia Engineering*, *5*, 192-195.
4. Ting, C. K., & Liao, C. C. (2010). A memetic algorithm for extending wireless sensor network lifetime. *Information Sciences*, *180*(24), 4818-4833.
5. Abdulla, A. E., Nishiyama, H., & Kato, N. (2012). Extending the lifetime of wireless sensor networks: A hybrid routing algorithm. *Computer Communications*, *35*(9), 1056-1063.
6. Behdani, B., Yun, Y. S., Smith, J. C., & Xia, Y. (2012). Decomposition algorithms for maximizing the lifetime of wireless sensor networks with mobile sinks. *Computers & Operations Research*, *39*(5), 1054-1061.
7. Castaño, F., Rossi, A., Sevaux, M., & Velasco, N. (2013). On the use of multiple sinks to extend the lifetime in connected wireless sensor networks. *Electronic Notes in Discrete Mathematics*, *41*, 77-84.
8. Yu, J., Deng, X., Yu, D., Wang, G., & Gu, X. (2013). CWSC: Connected k-coverage working sets construction algorithm in wireless sensor networks. *AEU-International Journal of Electronics and Communications*, *67*(11), 937-946.
9. Zhang, P., Xiao, G., & Tan, H. P. (2013). Clustering algorithms for maximizing the lifetime of wireless sensor networks with energy-harvesting sensors. *Computer Networks*, *57*(14), 2689-2704.
10. Aderohunmu, F. A., Paci, G., Brunelli, D., Deng, J. D., Benini, L., & Purvis, M. (2013, May). An application-specific forecasting algorithm for extending wsn lifetime. In *2013 IEEE International Conference on Distributed Computing in Sensor Systems* (pp. 374-381). IEEE.
11. Castaño, F., Rossi, A., Sevaux, M., & Velasco, N. (2014). A column generation approach to extend lifetime in wireless sensor networks with coverage and connectivity constraints. *Computers & Operations Research*, *52*, 220-230.
12. Halder, S., & Bit, S. D. (2014). Enhancement of wireless sensor network lifetime by deploying heterogeneous nodes. *Journal of Network and Computer Applications*, *38*, 106-124.
13. Bakr, B. A., & Lilien, L. T. (2014). Extending lifetime of wireless Sensor networks by management of spare nodes. *Procedia Computer Science*, *34*, 493-498.
14. Zhao, H., Guo, S., Wang, X., & Wang, F. (2015). Energy-efficient topology control algorithm for maximizing network lifetime in wireless sensor networks with mobile sink. *Applied Soft Computing*, *34*, 539-550.
15. Amgoth, T., & Jana, P. K. (2015). Energy-aware routing algorithm for wireless sensor networks. *Computers & Electrical Engineering*, *41*, 357-367.
16. Suganthi, K., Vinayagasundaram, B., & Aarthi, J. (2015). Randomized fault-tolerant virtual backbone tree to improve the lifetime of wireless sensor networks. *Computers & Electrical Engineering*, *48*, 286-297.
17. Taibi, F., & Meziani, K. (2015). A Hybrid Approach to Extend the Life Time of Heterogeneous Wireless Sensor Networks. *Procedia Computer Science*, *63*, 136-141.
18. Wankhade, N. R., & Choudhari, D. N. (2016). Novel Energy Efficient Election Based Routing Algorithm for Wireless Sensor Network. *Procedia Computer Science*, *79*, 772-780.
19. Azharuddin, M., & Jana, P. K. (2016). Particle swarm optimization for maximizing lifetime of wireless sensor networks. *Computers & Electrical Engineering*, *51*, 26-42.
20. Nayak, P., & Devulapalli, A. (2016). A fuzzy logic-based clustering algorithm for WSN to extend the network lifetime. *IEEE Sensors Journal*, *16*(1), 137-144.

