Study on Data Aggregation Method using Soft Computing Techniques in WSN

Geetidarshini Panigrahi[1], Sachinadan Mohanty[2]

*[*1]Department of Computer Science & Engineering, Gandhi Engineering College, Odisha, India*
[2]Department of Computer Science & Engineering, Gandhi Institute For Technology, Odisha, India

ABSTRACT: *The wireless sensor networks (WSN) comprise with huge number of sensor hubs operational together to play out some particular undertaking. The sensor hubs are ordinarily customized for checking the climate and gather Packets of data and pass them to client operator through the sink hub. The sink hub is intended for getting to data on distant mode by different correspondence advancements. Since, the low fueled hubs have a knowledge as a significant plan challenge to accomplish the lifetime expansion of organization. In this manner, plan and build up a viable information collection strategies that moderate restricted energy assets is a basic issue in WSN. There are number of information conglomeration procedures utilizing delicate registering methods with accessible yet at the same time it appears to be decreased measure of acceptable regarding continue their energy on whole organization. This investigation purposefully introduced for late overview of significant commitments to the energy proficient information accumulation which basically utilize delicate registering methods. In light of this, some classification of conventions delicate registering method as: fuzzy logic, swarm insight, hereditary calculation and neural organizations are examined.*
Keywords: Data aggregation, fuzzy, swam, ACO, GA

I.   INTRODUCTION

A Wireless Sensor Network (WSN) is a combination of a small light weighted wireless sensor nodes. These large set of densely coupled nodes are small, inexpensive and limited in power computation [1] [2]. Data aggregation is an essential standard for wireless routing in sensor networks [3] [4]. The main concept is to combine the data with different set of packets (heterogeneous) and similar set of packets (homogenous) which is intend for eliminating redundancy, minimizing the number of transmissions and thus saving energy. Collected information are transmitted to sink node in terms of reporting the information. Reports a r e s e n t t o the sink by the deployment of large number of sensors and their collaboration. Nodes in networks have the ability of self-organizing and monitoring capability. Through the multi-hop, nodes are handled and transmitted towards the sink node. These nodes achieve data collection, aggregation and communication from a remote environment[5].

1.1 Data aggregation

Data aggregation progresses the lifetime of nodes by eliminating redundant data transmission. The data transmission between neighbor nodes nearer to sink follows a multi -hop fashion. The existing techniques still need of an improved approach using aggregation. Clustering isusedwhere each cluster-head received raw data and taken into aggregation which is then sent to the sink. The data gathered from the sensor nodes comprisesof redundancy and it should be reduced using data fusion. These aggregation approaches involve lot of energy wastages. In case of homogeneous b a s e d the cluster- head, it will soon die out and again need more energy for re- clustering[6].

Investigating on the existing works necessary to work on some major factors such as: power consumption, reliability, aggregation overhead, fault-tolerance and concurrency. Thus a suitable data aggregation approaches with different perception is employed which improves efficiency and reduces the energy consumption [4]. Considering the merits and strength, accuracy can be performed by improving data aggregation process for the entire network [7]. The remainder of this paper is organized as follows. In this paper Section II explains the energy savings mechanisms involved in different types of data aggregation method and it describes various data aggregation using soft computing techniques with its benefits. Finally, this paper concludes the work in section III.

1.2 Types of aggregation techniques

Aggregation in sensor networks has attracted a lot of attention in the recent years and introduced unique challenges compared to traditional data aggregation in wired networks. In this paper, we have described recent research results on DA process in sensor networks and classified the approaches into some main categories, namely tree based, cluster based, flat based and cyclic based data aggregation. However, we have

also observed that there is a structure free approach is fit with many aspects. This section analyzed the different research direction of DA to reduce energy consumption.

Aggregating process is done with tree structure is called tree based approach. A typical data aggregation technique in wireless sensor networks consists a minimum spanning tree with sink node as root and communication nodes as leaves. This approach produces the optimal aggregation techniques. This kind of nodes are aggregated to form a tree with hierarchical levels. The intermediate node involves into aggregation process. Each leaf node send information to their parenting node. This spanning tree has the ability to reduce the data redundancy and so as to decrease the energy consumption[8].

The whole network is divided in to number of clusters in this approach. There is a head in each cluster is called cluster-head. Cluster-heads perform the role of aggregator which combine the data received from cluster members locally and then it transmits to the base station [9]. The data gather processing makes use of the hierarchical protocol based on clustered Architecture in [10]. The clustering process is performed as virtual backbone in the sensor network. Here, CHs are concerned with data transportation, and other cluster member nodes are free to follow their sensing tasks. This procedure can reduce the network energy consumption in number of steps as the neighbor discovery phase, CHs find phase and nodes ascription phase

In flat network each sensor nodes have a same battery power and plays the similar type of role in a network. In this type of networks, data aggregation is done in data centric routing manner. The sink usually sends a data packet to the sensor nodes, for example, flooding. Sensors that have data matching the data packet along with transmit response datapacketback to the sink in the flooding [11]. In this, each aggregation methods normally node has the same role and sensor nodes cooperate with each other to perform the sensing task. Since the number of these types of node is very large, so it is not possible to allocate a global identifier to each node. Therefore, Data centric routing is used, in which the base station sends queries to assured regions and waits for data from sensors located in the preferredregions.

A Cycle-Based Data Aggregation Scheme (CBDAS) was proposed with grid- based WSNs with a motto of extend the lifetime of a WSN. They designed the network with

2-D grid of cells and each cell has a head which has high residual energy. In this paper, cell head is linked together to form a cyclic chain. In whole round of cycling process, cell head is responsible for directly transmitting data to the BS as cycle leader. Simultaneously, all the other nodes periodically forward their sensed information to its cell head. After that, cycle header is responsible to aggregate the received the data[12].

II. EXISTING DATA AGGREGATION TECHNIQUESUSINGSOFT C O M PUTING METHODS

In this paper, some types of soft computing techniques for efficient data aggregation are discussed. They are fuzzy-based data aggregation, neural-based data aggregation, swarm-based data aggregation and genetic-based dataaggregation.

2.1 Fuzzy-based data aggregation technique

A fuzzyfication function takes set of fuzzy input values for interpretation and produced as a crisp output by defuzzification. This is a simple methodto combine the results from different raw data and taken for analysis on information in a linguistic manner. It takes values between 0 and 1 is assigned by the membership function. There are three components in a fuzzy system include fuzzifier, inference engine and defuzzifier. When the fuzzifier maps each crisp by assigning truth value or degree of membership for each fuzzyset.

A membership function (TMF) is mapping function which produces a curve according tothemappingvaluesoninput.TMFrangevaries(ordegreeofmembership)between0and

1. Always these universe of discourse values used to determines an output values as a maximum choice of response. The rules use the input membership values as weighting factors to determine the final output conclusion. A suitable means of determining the appropriate membership functions using fuzzy operations represented with meaningful linguistic states (low, high, small and large) of the input variables, the degrees of membership to these sets must remain constant for certain values of the universe of discourse.

Data fusion algorithms in cluster-based using fuzzy logic theory (DFA)

[14] follows the logic methods which reduces traffic and enhances the performance of networks. In this cluster-based DFA, only few data samples are required with less computational power in the basis of extracting final accurateresult is considered as a strength of this approach. At the same time the cost value is not reduced and no assurance for security on data fusion is considered as weakness of this approach.

In the NA [15], FDA considers the objects of s e c u r i t y , energy consumption, cost reduction and accuracy in its data aggregation tree with efficient routing. Swarm-based (or ACO) data aggregation technique Behaviour of the ants is derivatived in this ACO method. Many of the studies have proved that ants find the shortest path from the food source to nest using the pheromone values. The p a t h determination of the next

movement for an ant can be guided by the pheromone values [16] which serves as a critical communication medium among ants. Target path is updated the trails with rich pheromone. ACO technique with rules as state transition and pheromone updating was developed to find out the best path of an ant. Once the ants a r e placed on a starting node, on repetition basis, state transition rule forms a solution for each ant and local pheromone- updating rule is to adjust the quantity of pheromone on its visited path periodically[17].

The main issue for data gathering on event based is the restricted communication range for each node. Due to the restriction, communication range and high network density, event forwarding are considered very challenging issues. It requires multi-hop data forwarding. In [18,] the energy-efficient ant based routing (EEABR) algorithm, based on the ant colony optimization (ACO) proposed three improvements to the EEABR algorithm as intelligent routing scheme, intelligent updating of routing tables and reducing congestion control. The author proved and shown that the energy efficiency by upto9%and64%inconverge-cast andtarget-trackingscenarios isachieved.

Simulated annealing algorithm for data aggregation in sensor networks [19] have stated and proved a simulation annealing algorithm for constructing data aggregation tree in WSNs. Using fitness function. The rate of energy consumption at every data aggregation tree is simulated. The author finds the paths that connect two energy nodes are obtained by annealing method. The related data packets are combined in intermediate nodes and form one package which automatically reduced the number of transmission. For that, this data collection algorithm compared against GA-based data aggregationtree.

2.2 GA-based data aggregation technique

Based upon the progression ideas of natural selection GA was proposed in the field of genetics, adaptive heuristic search algorithm. It gets the rapid growing and reorganization in artificial intelligence with advancement computing level.

1. Chromosomes connect the genes together which is having the long strings,
2. Specific trait of the organism is signified by each gene.
3. Genotype of organism reflected on the gene and their settings.
4. Mating of two organisms get shared data of genes and offspring which refers crossover.
5. Then the mutation of the newly created offspring is being articulated as a completely new trait.
6. Fitness measurement of the organism get the result of success organism in its lifetime [19].

Novel hybrid GA-artificial Bee colony (ABC)-based energy efficient clustering proposed into two phases as configuration phase and data aggregation phase [20]. Energy consumption is a major objective in cluster head environment but at same time the results do not provide accurate values and the routing. Data aggregation a n d routing using Grid- based routing and aggregator selection scheme (GRASS) [21] is proposed with the objective of low energy dissipation and low latency without compromising on quality. Redundancies are removed by limiting fewer numbers of bits transmission hence reduce energy consumption which automatically increases the lifetime of sensor nodes. But the results hasnot assured for accuracyvalues.

A tree-based data aggregation scheme using GA [22] have proposed formaking use of GA to achieve an efficient data aggregation tree. The fitness function in GA measured from each node in terms of assigned residual energy, number of transmission and received data packets to individuals. In further, optimal paths achieved by data aggregation tree by load balancing and energy conserved are attained. This work suitable for data aggregation process which has only on a homogeneous sensor networks. The author described the analysis in [23] focus on optimizing important performance measures such as network lifetime, data latency, data accuracy and energy consumption. Efficient routing and data aggregation tree construction, energy efficiency, data accuracy and latency are the main focus of data aggregation algorithms. The following table 1 stated various protocols with soft computing techniques on dataaggregation.

Table 1: Soft computing techniques based protocols on data aggregation

Protocol	Soft computing techniques	Aggregation type	Energy	Cost estimation	Security	Accuracy
DFA [14]	Fuzzy	Cluster	☐	☐	x	x
NA [15]	Fuzzy	-	☐	x	x	☐
FBA [23]	Fuzzy	Tree	☐	x	x	☐

MADFT [24]	Swarm	Tree	□	□	x	x
T-ANT [27]	Swarm	Cluster	□	□	x	□
ANTAR [25]	Swarm	Tree	□	□	x	x
GA-ABC [26]	Genetic	Cluster	□	x	x	x
GRASS [20]	Genetic	Tree	□	x	x	x
GA [21]	Genetic	Tree	□	□	x	□

III. BENEFiTS OF USING SOFT COMPUTING TECHNIQUES IN DATA AGGREGATION

The soft computing paradigms are encompasses it performance by the techniques asartificial neural networks (ANN), genetic algorithms (GA), fuzzy logic models and particle swarm techniques. The accuracy of the aggregation by considering the parameters such as path length, link quality, energy level of node, quality neighbor node selectionon designing multi-path routing algorithm. An optimized problem solving technique are used for efficient aggregation process with above mentioned parameters. Antcolonyoptimization (ACO), Distributed computing, self- organization and positive feedback comprises the characteristics of the ACO algorithm. This kind of approaches in m o d e r n communication networks customs ACO algorithm for route searching and route maintenance table[13].

IV. CONCLUSION

In this paper, the data aggregation using soft computing techniques has benefited and additionally instigated some issues because of the soft computing techniques in data aggregation has been reviewed. A complete overview a b o u t the parameters as energy consumption, cost reduction, accuracy, number of transmission and security is provided here. The soft computing techniques used in data aggregation using the swarm, fuzzy, neural and genetic has been studied in this paper. The merits and demerits of these aggregation techniques are summarized in order to articulate the performance of approaches. Most of the aggregation techniques deliberate only the energy conserving manner. Finally, the discussion is taken in to concluding that a new technique need to be developed for improving aggregation ratio, reducing topology maintenance cost and latency and better coverage using the fuzzy and swarm AI techniques and it should deliver increased energy conservation in efficient manner.

REFERENCES

[1] Mohamed K. Watfa and SeshCommuri. "An Energy Efficient Approach to Dynamic Coverage in WirelessSensorNetworks".InJournal of Networks 1(4)(2006).

[2] Khin Thanda Soe. "Increasing Lifetime of Target Tracking Wireless Sensor Networks". World Academy of Science. In Engineering and Technology42 (2008).

[3] J. Heidemann et al. "Building Efficient Wireless Sensor Networks with Low-Level Naming". In: 18th ACM Symposium on Operating Systems Principles.(Oct.21-24,2001).

[4] M.Umadevi and Dr.M.Devapriya." Perceptions on Data Aggregation in Wireless Sensor Network". In: International Journal of Advance Foundation and Research in Computer2(7)(2015)

[5] Zhao, J., Erdogan, A., Arslan, T. "A Novel Application Specific Network Protocol for Wireless SensorNetworks". In: IEEE Int. Symp. on Circuits and Systems (2005) (ISCAS'05)5894–5897.

[6] Patil, N., Patil, P. "Data Aggregation in Wireless Sensor Network". In: IEEE Int. Conf. on Computational Intelligence and Computing Research.(2010).

[7] Watfa, M., Daher, W., Azar, H. " A Sensor Network Data Aggregation Technique". In Int. J. Comput. Theory Eng. (1) 19–26 (2009).

[8] Yao Lu, Jianping Chen, IoanComsa, Pierre Kuonen and Beat Hirsbrunner." Construction of Data Aggregation tree for Multi-objectives in Wireless Sensor Networks through Jump Particle Swarm Optimization". In: 18 International Conference on Knowledge-Based and Intelligent Information & Engineering Systems(2014).

[9] Rashmi Ranjan Rout, Soumya K. Ghosh. "Adaptive Data Aggregation and Energy Efficiency Using Network Coding in a Clustered Wireless Sensor Network: An Analytical Approach". In Computer Communications (40), 65–75. (2014).

[10] Xin Song, Xi Hu, Cuirong Wang and Jing Gao.” DLRDG: Distributed Linear Regression- Based Hierarchical Data Gathering Framework in Wireless Sensor Network”. In Neural Comput & Applic, (23) 1999–2013(2013).

[11] Shushruta Mishra and Hiren Thakkar.” Features of WSN and data aggregation techniques in WSN: A survey”. In International Journal of Engineering and Innovative Technology 1(2012).

[12] Yung-Kuei Chiang, Neng-Chung Wang and Chih-Hung Hsieh. “A Cycle-Based Data Aggregation Scheme for Grid-Based Wireless Sensor Networks”. In Sensors14 (2014).

[13] Yang, J., Zhao, W., Xu, M., Xu, B. “A multipath routing protocol based on clustering and ant colony optimization for wireless sensor networks”. In Int. J. Comput. Netw. Inf. Secur. (1) 49–59(2009).

[14] Su, W., Bougiouklis, T. ”Data Fusion Algorithms in Cluster-based Wireless Sensor Networks using Fuzzy Logic Theory”. In: Proc. 11th WSEAS Int. Conf. on Communications (July 2007) Agios Nikolaos, Crete Island, Greece.26–28.

[15] Croce, S., Marcelloni, F., Vecchio, M.” Reducing power consumption in wireless sensor networks using a novel Approach to Data Aggregation”. In Comput. Journal 51(2) 227–239(2008).

[16] M.Umadevi and Dr.M.Devapriya. “An Enhanced Ant Colony Based Approach to optimize the usage of CriticalNodeinWirelessSensorNetworks”.In Procedia ComputerScience 452-459(2015).

[17] Huang, S.”Enhancement of Hydroelectric Generation Scheduling Using Ant Colony System Based Optimization Approaches”.In IEEE Trans.Energy Convers 16(3)296–301(2001).

[18] Adamu Murtala Zungeru, KahPhooi Seng, Li-Minn Ang, and Wai Chong Chia. “Energy Efficiency Performance Improvements for Ant-Based Routing Algorithm in Wireless Sensor Networks”. HindawiPublishingCorporation,JournalofSensors.(2013).

[19] Chakraborthy, R,” Basics of soft computing”. In Soft Computing Course Lecture. (2010). [20] Mehrjoo, S., Aghaee, H., Karimi, H.”Novel Hybrid GA-ABC Based Energy Efficient Clustering In Wireless Sensor Network”. In Can. J. Multimedia Wirel. Netw. 2(2) 41–45,(2011).

[20] Al-Karaki, J., Ul-Mustafa, R., Kamal, E.A.”Data Aggregation and Routing In Wireless Sensor Networks: Optimal and Heuristic Algorithms”. In Int. J. Comput. Telecommun. Netw. 53(7) 945–960 (2009).

[21] Norouzi, A., Babamir, F., Orman, Z. ”A tree based data aggregation scheme for wireless sensor networks using GA”. In Sci. Res., Wirel. Sens. Netw. 4, 191–196(2012).

[22] De Cristofaro, E., Bohli, J., Westhoff, D.”FAIR: Fuzzy-Based Aggregation Providing In- Network Resilience for Real-Time Wireless Sensor Networks”. In: Proc. of the Second ACM Conf. on Wireless Network Security (2009) WiSec’09 (16)253–260.

[23] Nagarajan, V.”Anycast Routing In Wireless Sensor Networks” In Int. J. Eng. Sci. Technol. 2 878–885 (2010).

[24] Juan, L., Chen, S., Chao, Z.”Ant System Based Anycast Routing In Wireless Sensor Networks”. In: IEEE Int. Conf. on Wireless Communications, Networking and Mobile Computing (September 2007) WiCom’072420–2423.

[25] Islam, O., Hussain, S. “Genetic Algorithm for Data Aggregation Trees in Wireless Sensor Networks”. In: IEEE Third IET Int. Conf. on Intelligent Environments (2007)312–316,

[26] Selvakennedy, S., Sinnappan, S., Shang, Y.”T-ANT: A Nature-Inspired Data Gathering Protocol for WirelessSensorNetwork”.InJournalofCommun.1(2)22–29(2006).