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Review of Data Aggregation in WSN using Soft Computing Approach

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Abstract: *The wireless sensor networks (WSN) consist with large number of sensor nodes operational together to perform some specific task. The sensor nodes are typically programmed for monitoring the environment and collect Packets of information and pass them to user agent through the sink node. The sink node is designed for accessing information on remote mode by various communication technologies. Since, the low powered nodes have an insight as an important design challenge to achieve the lifetime maximization of network. Therefore, design and develop an effective data aggregation techniques that conserve limited energy resources is a critical issue in WSN. There are number of data aggregation techniques using soft computing techniques with available but still it seems reduced amount of satisfactory in terms of sustain their energy on entire network. This study intentionally presented for recent survey of major contributions to the energy efficient data aggregation which mainly use soft computing techniques. Based on this, some classification of protocols soft computing technique as: fuzzy logic, swarm intelligence, genetic algorithm and neural networks arediscussed.*

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 isusedwhereeach cluster-head received raw data and taken into aggregation which is then sent to the sink. The data gathered from the sensor nodes co mprisesof 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 tothemapping values on input.TM Frangevaries(or degree of membership) between 0and
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-trackingscenariosisachieved.

Simulated annealing algorithm for data aggregation in sensor networks [19] have stated a n d p r o v e d 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.

- Chromosomes connect the genes together which is having the long strings,
- Specific trait of the organism is signified by each gene.
- Genotype of organism reflected on the gene and their settings.
- Mating of two organisms get shared data of genes and offspring which refers crossover.
- Then the mutation of the newly created offspring is being articulated as a completely new trait.
- 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 aggregationand 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 has not 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	□

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 selectionond esigning 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].

III. Conclusion

In this paper, the data aggregation using soft computing techniques has benefited and additionally instigated some issues because of the soft computing techniquesindata 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 meritsand 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 i n 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 efficientmanner.

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