SOFT COMPUTING TECHNIQUES BASED DATAAGGREGATIONINWIRELESSSENSORNETWORKS – A REVIEW

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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 modeby 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 thatconserve limited energy resources is a critical issue inWSN. 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. Thisstudy intentionally presented for recent surveyofmajorcontributionstotheenergy efficient dataaggregation which mainlyuse softcomputingtechniques. Based on this, some classi cationofprotocolssoftcomputing techniqueas:fuzzylogic,swarmintelligence, geneticalgorithmandneuralnetworks are discussed.

Keyword: data aggregation, fuzzy, swam, ACO, GA.

Introduction

A Wireless Sensor Network (WSN) is a combination ofasmalllightweighted wireless sensornodes. 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, minimizingthe number of transmissions and thus saving energy. Collected information are transmitted to sink node in terms of reporting the information. Reports aresentto the sink by the deployment oflargenumberofsensorsandtheir collaboration. Nodes in networks have the ability of self-organizing and monitoringcapability. Through the multi-hop, nodes are handled and transmitted towards the sink node.These nodesachievedata collection, aggregationandcommunication fromaremote environment[5].

Data aggregation

Dataaggregationprogresses thelifetimeofnodesby eliminating redundantdatatransmission.Thedata transmissionbetween neighbornodesnearertosink follows amulti-hop fashion. Theexistingtechniques still need of animproved approachusingaggregation.Clustering isusedwhereeachcluster-head receivedraw data and taken intoaggregation whichisthensenttothesink. Thedata gathered fromthesensornodes comprisesofredundancyandit should be reducedusingdatafusion. Theseaggregation approachesinvolvelotofenergywastages. Incaseofhomogeneousbased thecluster-head, it willsoondieoutandagain need more energy for re-clustering[6].

Investigating ontheexistingworks necessary toworkon some major factors suchas:powerconsumption, reliability, aggregationoverhead,fault-tolerance andconcurrency.Thusasuitabledataaggregationapproaches with different perception isemployedwhichimproves ef ciency andreducesthe energyconsumption[4].

Consideringthemerits and strength, accuracy can be performed by improving data aggregation process for theentirenetwork [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 Section III describes various data aggregation using soft computing techniques with its benefits. Finally, this paper concludes it work in section IV.

Typesofaggregationtechniques

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 describedrecent research results on DA process in sensor networks and classi ed the approaches into some maincategories, namely tree based, cluster based, flat based and cyclic based data aggregation. However, wehave also observed that there is a structure free approach is t with many aspects. This section analyzedthe 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 andcommunication nodes as leaves. This approach produces the optimal aggregation techniques. This kindof nodes are aggregated to form a tree with hierarchical levels. The intermediate node involves intoaggregation process. Each leaf node send information to their parenting node. This spanning tree has theability 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 fromcluster 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 areconcerned with data transportation, and other cluster member nodes are free to follow their sensingtasks. This procedure can reduce the network energy consumption in number of steps as the neighbordiscovery phase, CHs nd phase and nodes ascription phase.

In flat network each sensor nodes have a same battery power and plays the similar type of role in anetwork. In this type of networks, data aggregation is done in data centric routing manner. The sinkusually sends a data packet to the sensor nodes, for example, flooding. Sensors that have data matchingthe data packet along with transmit response data packet back to the sink in the flooding [11]. In this, each aggregation methods normally node has the same role and sensor nodes cooperate with each otherto 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 stationsends queries to assured regions and waits for data from sensors located in the preferred regions.

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 headwhich has high residual energy. In this paper, cell head is linked together to form a cyclic chain. In wholeround 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. Afterthat, cycle header is responsible to aggregate the received the data [12].

Existingdataaggregation techniques usingsoft computingmethods

Inthispaper,sometypesofsoftcomputingtechniquesforefficientdataaggregationarediscussed. Theyarefuzzy-based data aggregation,neural-based dataaggregation,swarm-based dataaggregationandgenetic-baseddataaggregation.

Fuzzy-baseddataaggregationtechnique

Afuzzyficationfunctiontakes set of fuzzy input values forinterpretation and produced as a crisp output bydefuzzification.Thisisasimplemethodto combinetheresultsfromdifferentraw data and taken for analysisoninformationinalinguisticmanner. It takes values between0and1is assignedbythemembershipfunction.There are three components in a fuzzy system include fuzzi er, inferenceengineanddefuzzi er. When thefuzzi ermapseachcrisp by assigning truthvalueordegreeof membershipfor eachfuzzy set.

A membership function (TMF) is mapping function which produces a curve according to the mapping values on input. TMF range varies (or degree of membership) between 0 and 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 fusionalgorithmsincluster-basedusing fuzzy logic theory (DFA) [14] follows the logic methodswhichreduces traf candenhances the performance of networks.Inthiscluster-basedDFA,onlyfewdatasamplesarerequired with less computational power inthe basis of extracting nalaccurateresult is considered as a strengthofthisapproach. At the same time thecostvalueisnotreduced and no assurance for security on data fusion is considered as weaknessofthisapproach.

IntheNA[15],FDA considers the objects of security, energyconsumption, costreduction and accuracy initsdataaggregationtree with efficient routing. Swarm-based(orACO)dataaggregation techniqueBehaviouroftheantsisderivativedinthisACOmethod.Many of the studies haveproved thatants ndtheshortest pathfromthefoodsourcetonest usingthepheromone values.Thepath determinationofthe next movement for an ant can be guided by the pheromone values [16]which serves as a critical communication mediumamong ants. Targetpathisupdated the trailswith richpheromone.ACOtechnique with rules as statetransitionandpheromoneupdating was developed to find out thebestpath of an ant. Once the ants are placedonastartingnode,on repetition basis, statetransition ruleformsasolutionforeachant andlocalpheromone-updating rule is toadjust the quantityof pheromoneon 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 up to 9% and 64% in converge-cast and target-tracking scenarios is achieved.

Simulated annealingalgorithmfordata aggregation insensornetworks [19]have statedand proved a simulationannealingalgorithmfor constructingdata aggregationtreein WSNs. Using tnessfunction. Therate of energyconsumptionateverydataaggregationtreeissimulated. The author finds the paths thatconnecttwoenergynodesareobtained 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-baseddataaggregationtree.

GA-baseddataaggregationtechnique

Baseduponthe progressionideasofnaturalselection GA wasproposed in the field of genetics,adaptiveheuristic searchalgorithm. It gets the rapid growing and reorganization in arti cial intelligence with advancement computing level.

- Chromosomes connectthegenes together whichis having the longstrings,
- Specifictraitoftheorganismissignified byeachgene.
- Genotype of organismreflected on thegeneandtheirsettings.
- Mating oftwoorganisms get shared data of genesand offspring whichrefers crossover.
- Thenthemutationofthenewlycreatedoffspringisbeing articulated asa completelynewtrait.
- Fitnessmeasurementoftheorganism get the result of successorganisminitslifetime[19].

Novel hybrid GA-arti cial Bee colony (ABC)-basedenergy ef cient clusteringproposedinto twophases as con guration phase and dataaggregationphase[20]. Energy consumption is a major objective in cluster head environment but at same time theresultsdonotprovideaccurate valuesandtherouting.Data aggregation and routing usingGrid-based routing and aggregator selection scheme (GRASS) [21]is proposed with the objective of low energy dissipationandlow latency without sacri cing quality.Redundanciesareremovedby limiting fewernumbersof bits transmission hence reduceenergy consumptionwhich automatically increases thelifetime of sensornodes. But the resultshas not assured for accuracyvalues.

Atree-baseddataaggregation schemeusing GA[22] haveproposedfor makinguseofGA to achieve anef cient dataaggregationtree.The tnessfunction inGA measured from each node in terms of assigned residual energy,numberoftransmission and receiveddatapacketstoindividuals.In further, optimalpaths achieved by dataaggregationtree by loadbalancing andenergy conserved areattained. This work suitable for dataaggregationprocess which has only on ahomogeneoussensornetworks. The author described the analysis in [23]focusonoptimizingimportant performance measures suchasnetworklifetime,datalatency,data accuracyand energy consumption. Ef cient routinganddataaggregationtree construction, energyef ciency,data accuracyandlatency arethemainfocusofdataaggregationalgorithms. The following table 1 stated various protocols with soft computing techniques on data aggregation.

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	✓

Bene tsofusing soft computingtechniquesin dataaggregation

The soft computingparadigms are encompasses it performance by the techniques as arti cial neuralnetworks(ANN), geneticalgorithms (GA),fuzzylogicmodelsandparticle swarmtechniques. Theaccuracyofthe aggregation by considering the parameters suchaspathlength, link quality, energy level of node, quality neighbor node selection on designingmulti-path routingalgorithm.An optimized problem solving technique are used for efficient aggregation process with above mentioned parameters. Antcolony optimization (ACO),Distributedcomputing,self-organization andpositivefeedbackcomprisesthecharacteristicsoftheACO algorithm. This kind of approaches in m o d e r n communicationnetworkscustomsACO algorithm forroutesearching and route maintenance table [13].

Conclusion

Inthispaper,thedataaggregationusingsoftcomputingtechniqueshasbene tedandadditionallyinstigatedsom e issues becauseofthe softcomputingtechniquesin dataaggregationhavebeen reviewed. A complete overview a b o u t the parameters as energyconsumption,costreduction,accuracy, number of transmissionandsecurity is provided here. The soft computing techniquesusedindataaggregation using the swarm, fuzzy,neural andgenetichasbeenstudied inthispaper. The merits and demerits of these aggregation techniques are summarized in order to articulatethe performance ofapproaches. Mostofthe aggregationtechniquesdeliberate onlytheenergy conserving manner.Finally,thediscussionistakeni n toconcludingthatanewtechniqueneed tobedeveloped for improving aggregation ratio, reducing topology maintenance cost and latency and better coverage using thefuzzyand swarmAItechniquesandit shoulddeliverincreased energy conservationin efficient manner.

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