Asian Journal of Information Technology 14 (8-12): 276-280, 2015
ISSN: 1682-3915

EDRINA: Enhanced Data Routing for In-Network Aggregation Algorithm for WSNS

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Abstract: Currently, the wireless sensor network is facing four major issues namely power management, routing, localization and deployment techniques. Out of these in power management, energy conservation is the major constraint due to irreplaceable and limited power sources of the sensor nodes. Therefore, efficient cluster formation is very challenging in WSNs by considering the energy consumption of cluster heads. In this research, we propose a novel enhanced data routing For In-Network Aggregation algorithm is that here we are using the concept of intelligent routing, i.e., ant colony optimization which provides optimized path for route formation that connects to all source nodes to sink while maximizing data aggregation throughout the whole network. The projected algorithm was extensively compared to other known solution: data routing for in-network aggregation algorithm. Our results clearly indicate that routing path built by genetically driven algorithm providesoptimized routing quality and best aggregation quality with more energy consumption when compared to other algorithm.

Key words: Routing protocol, in-network aggregration, ant colony optimzation, wireless sensor networks, energy

INTRODUCTION

Wireless Sensor Network (WSN) is a form of network that consists of a large number of sensors which are very small in size and less costly. With the help of recent advancements in wireless communication and technologies these sensor nodes can be able to sense environment information, process the gathered data and also deliver that information to the main base station via different wireless channels. Main applications of sensor networks are data gathering processes such as environmental monitoring, Body area networks, military services etc. These sensors send data either in periodic manner or in the event wise according to the desired application.

Although, these sensor nodes are different in physical size but complexity of sensor nodes decides the cost parameter. From the view point of cost these sensors are inexpensive which mainly leads to limited power supply. Energy source of sensors are batteries which cannot be replaceable and recharged. So, energy efficiency is the major constraint in WSN. Within the network, routing and medium access protocols are mainly responsible for carrying out communication among the nodes. Route formation is the main issue as route formation should be such that it takes less time to send packets and also if route is long then again nodes take more energy to stay in network. Hence, routing is also important design goal in sensor networks. Since, wireless sensor networks have main energy shortage and route formation characteristic as mentioned above, so our aim is to optimize the route formation from source to sink using distance and energy as the main factor.

PRESENT RESEARCH SCENARIO

During routing in WSNs, there are different protocols and algorithms are used for data collection and aggregation processes. Some of them are tree approach while others are cluster based approach and layered approach. In in-network data aggregation, inter-mediate nodes behave as the parent nodes and it will accept all data from their child nodes (Fasolo *et al*., 2007), i.e., child nodes are the node which are sending data to the intermediate nodes or cluster heads and hence whole data when aggregated and at last it will sent whole data to the

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sink or destination (Al-Karaki and Kamal, 2004). In the layered architecture of WSN, there is only one strongest base station and around, it there are various layers of sensor nodes which communicate to other nodes having same hop-count to the base station. Example: Unified Network Protocol Framework (UNPF) follows layered architecture and is set of protocols for whole implementation of a layered architecture for wireless sensor networks. UNPF have three operations network initialization and maintenance, Medium Access Control (MAC) and routing protocols (Dargie and Poellabauer, 2010). In the tree based approaches, the first step is the formation of tree structure after that data or information can be routed from source to sink using this tree structure. However, there are any limitations of this structure as soon as a packet of data is lost at any stage of the tree then data from whole sub tree will also vanished and due to this limitation, the tree based approach uses route repair mechanism (Villas *et al*., 2013).

In the cluster based approaches, all nodes in the network will form clusters in the network. Also, special type of nodes are there are called cluster heads or group leaders which are used to aggregate or gather information data from all other member nodes of that particular cluster and forward that gathered information to the destination node or sink. There are two types of network on the basis of sensor nodes involved and these are homogenous and heterogeneous networks. In direct transmission technique, all nodes are in range of base station and can send data directly to Base Station (BS). So, there is no need of cluster formation here. But, the Drawback is that nodes which are far away from BS die easily or run out of energy because they lose more energy in transmitting data to BS due to large distance between nodes and BS. Another method is Minimum Transmission Energy (MTE) which is based upon minimum cost routes as data is routed over routes which involve minimum cost. As a result of this, nodes which are closer to destination act as relays and have more probability to die early than nodes which have more distance from destination. An improper use of energy leads to less life cycle of network. Hence,energy in these sensors is an important resource and must be manage in an efficient manner. However, anotherimportant routing protocol is Low-Energy Adaptive Clustering Hierarchy (LEACH) (Shukla, 2013) it is based purely upon clustering technique which is not used by DT or MTE. Cluster Heads or leaders elected randomly in each round in this. In LEACH based algorithm, CH communicate with BS no matter of distance and this leads to die of CH early and also lost of whole data and information cannot be send to BS in this case. In order to improve these problems, LEACH-TCH also been developed where TCH means two level cluster heads (Baranidharan and Shanthi, 2010). There are many heterogeneous protocols as well in which all nodes have different energy levels such as Stable Election Protocol (SEP), extension of SEP and Heterogeneous SEP in these various classification of nodes are there on basis of their energy levels like advance nodes which are also declared as CH because they have higher energy in network, intermediate nodes have medium energy levels, normal nodes which are ordinary nodes.

For instance, the Data Routing for In-Network (DRINA) algorithm uses a simple approach to build a routing tree with shortest paths that connect all source nodes to sink while maximizing data aggregation (Villas *et al*., 2013). In this approach, the whole process complete in the three phases. In the first phase, a hop tree is built from source to sink which further used by the intermediate nodes for data forward purpose and in second phase, cluster formation and cluster head election occur on the basis of distance to the destination occurred and in the last phase, hop tree updation process is being done. There are some drawbacks in this algorithm as after nodes form the cluster they go for leader advertisement process where nodes send messages to each other to elect themselves as the cluster head (Villas *et al*., 2013). As this process consumes energy, since mutual broadcasting takes place among the nodes and also route formation is being done using tree approach which limits the energy of the network. Our proposed algorithm, enhanced data routing for In-Network Aggregation algorithm is also a cluster-based approach. In proposed algorithm for every new event, it is performed clustering of nodes as well as CH election on basis of residual energy which overall improves energy consumption of the network and after that for route formation there we have used the ant colony optimizationconcept (Wang *et al*., 2008). Also another way from the DRINA our algorithm does not use mutual broadcasting for leader election process which consumes more energy as well.

SYSTEM MODEL (ENHANCED DATA ROUTING FOR IN-NETWORK AGGREGATION ALGORITHM)

The main goal of our proposed Enhanced Data Routing, For In-Network Aggregation algorithm is that here, we are using the concept of intelligent routing, i.e., ant colony optimization which provides optimized path for route formation, so as to connects to all source nodes to

destination node while maximizing data aggregation throughout the whole network. In this algorithm, sensor nodes called as collaborators and CHs as co-ordinator as given below:

- Collaborator: nodes that send data to the cluster head are collaborators and non-cluster head nodes in a particular cluster
- Coordinator: nodes which detect an event and is leader or head of the cluster. It is also responsible for gathering all collected data send by collaborator nodes, aggregating them and finally transfer to the sink
- Sink: it is that destination node which receives information data from all other collaborators and coordinator nodes
- Relay: it is the node in the network that forwards data toward the sink

This algorithm completes the whole process in two phases. In Phase 1, the cluster formation is done on the basis of nodes which have detected the same event and also consists of formation of initiator node and CH election within nodes on the basis of residual energy. Phase 2 is liable for both setting up optimized path using ant colony optimization and dependable delivery of packets to sink.

Phase 1; cluster formation and CH election on the basis of residual energy: When asame event is detected by one or more nodes in the network then those nodes who detected the same event are divided into clusters. When the first event occurs after they form group they go for the leader election procedure. Here, we intend to use the concept of initiator node which will start the process. Initiator will be random node chosen out of those which detected as event, it sends hello message to nodes informing them about detection of the event. Each node sends the remaining energy level in reply to the imitator node. Then, the remaining energy of the nodes will be taken as the major factor to select one leader, i.e., coordinator among those which detected the same event and organized themselves into cluster. The remaining nodes that detected the same event will be the collaborators. The coordinator collects the whole information collected by collaborators and sends this to the sink. The importance of this algorithm is that information gathered at single node, i.e., coordinator which is better than other aggregation processes. Since, the cluster head has two main functions, namely data aggregation and data routing, so the cluster head of any cluster needs to work for longer duration. Once the leaders are elected on the basis of the highest remaining energy, next aim is to route the data towards the sink. The elected leader will broadcast forward ant agents towards the sink to form the route (Algorithm a).

Algorithm a: cluster formation

```
Let N: no of nodes that detected  same event
Initiator =rand ();
for i =1 : N
Initiator    Node(i)
Hello msg
Node(i) reply with Ei(energy)
end
Initiator select node with highest energy as CH
```

Phase 2; route formation using ant colony optimization: Here we aim to use the concept of ant colony optimization where the forward ant agents are broadcasted to find a route. Finally, the elected group leader starts broadcasting the forward ant agents towards the sink to form the route for the event dissemination. For that, the coordinator sends forward ants to their closest neighbor and then these neighbor nodes forward ant agents to one-hop neighbor and further to two-hop and 3-hop neighbors respectively in order to find the optimized route.The node for which pheromone value will be highest and for which energy will be highest will be chosen as next intermediate node. After that leader node will perform aggregation of the data from collaborators and outside the cluster aggregation is being done by relay nodes. So, we aim to optimize the route formation from source to destination using the distance and energy as the main factor into account (Algorithm b).

Algorithm b; route formation using ant colony optimization

```
for i=1:M //M:total number of sensors
CH broadcasts FANTs to M (i)
If M(i) has path to destination
Than call BANT().
Else
Broadcast till destination is found
End
Func:BANT()
Destination reply back to CH via multiple paths
Source selects path with highest pheromone.
IN: set of intermediate nodes
for i=1: IN
for j=1:M
IN (i) M (j)
Intermediate node informs other nodes to join them if they have data to send
end
end
```

SIMULATION SETUP

At last, we evaluate the proposed algorithm and compare its performance and results to other known base

algorithm DRINA. The base algorithms being chosen for being well known in the literature and we evaluate the genetically driven cluster based data routing under the following metrics: routing overhead, throughput, energy consumption. The simulation is performed in Network Simulator 2.30 tool. NS2 (Network Simulator Version 2) is the ideal platform to develop, test and deploy networking environment. Initially 100 joules of the energy was provided to the nodes which are deployed randomly in the sensor field of 1300×1000 x and y-axis distance. The nature of the nodes is static in the starting while dynamic in cluster head electionphase. Some parameters used to evaluate the performance of the network are given as:

- Throughput: another important factor that determines the performance of the network is throughput. It is the amount of data received at destination node
- Routing overhead: it shows how many routing packets needs to be sent in the network to receive the data packets. The routing overhead is calculated with the formula: no of routing packets sent/no of data packets received at the destination. Lesser the routing overhead in the network, better it is for the network or It is ratio of RTR packets to the AGT packets received
- Energy consumption: it is the major parameter to check the performance of network and hence, this provides the amount of energy remained

In the simulation scenario, In the simulation scenario, Fig. 1a represents that throughput comparison of the proposed algorithm is almost 20% more than that of base algorithm, i.e., DRINA and in Fig. 1b, the remaining energy is determined as the DRINA's remaining energy was about 60 joules only whereas 40 joules of energy was consumed while in proposed algorithm, 75 joules of energy was left and only 15 joules of energy was consumed in the network which clearly shows that more energy was left in the proposed algorithm and in the result Fig. 1c, routing overhead for the base algorithm DRINA is about 85 observed where as our proposed algorithm routing overhead is about 45, i.e., half of the base study routing overhead and also less the routing overhead, better the network is maintained. The results declared in this part clearly shows that our proposed enhanced data routing for in-network algorithm is more efficient and reliable than DRINA base algorithm in all considered scenarios in terms of routing overhead, throughput and energy consumption as well.

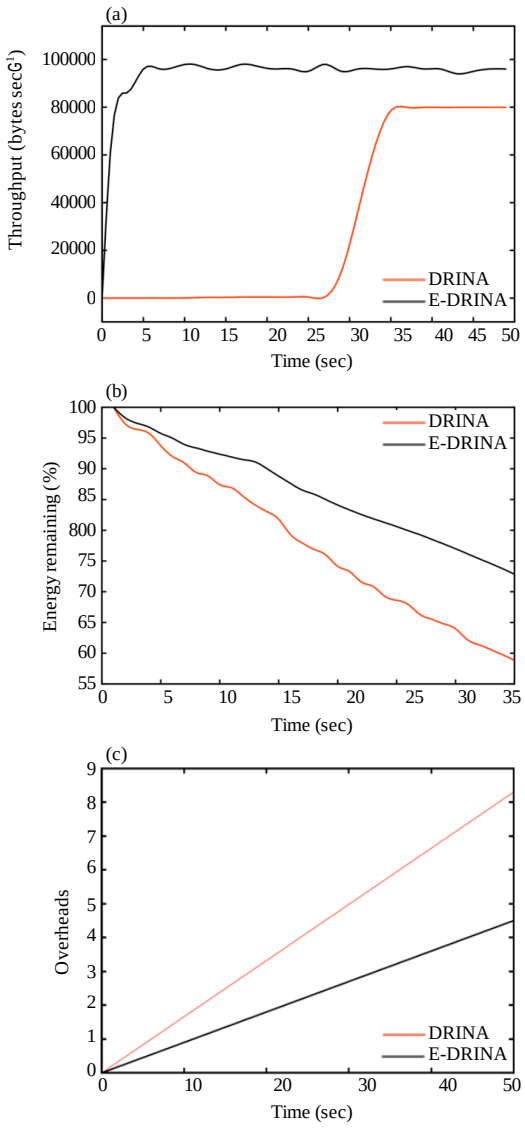

Fig. 1: a) Throughput comparison of algorithm; b) Energy consumption of proposed algorithm; c) Routing overhead

CONCLUSION

In this study, we study that aggregation based routing protocols plays an important role in event based WSNs. We presented a novel and reliable genetically driven cluster based routing algorithm and our proposed algorithm was extensively compared to other known DRINA algorithm regarding routing overhead, throughput and the major energy consumption parameters. By using the concept of intelligent routing, i.e., ant colony optimization and Initially 100 joules of the energy was provided to the nodes offering coordinator election on the

basis of residual energy to improve energy consumption, the obtained results clearly show that genetically driven cluster based routing algorithm outperforms DRINA for all evaluated scenarios. The process of data aggregation and fusion among clusters is also one of the interesting problems to explore.

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