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Multiple Sink Placement Algorithm in Wireless Sensor Networks using PSO Approach

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Abstract

Minimizing energy consumption and maximizing network lifetime are two important challenges in battery operated Wireless Sensor Networks (WSNs). Sensor nodes sense the environment periodically and forward the collected data to a sink. In a single sink WSNs, nodes closer to the sink become overburdened for relaying excessive data. This may incur faster energy consumption by nodes and lead an energy hole around the sink. As a result, the network lifetime is shortened. Multiple sinks mitigate this problem, reduce energy consumption at nodes and prolong the network lifetime by distributing the traffic over multiple sinks. Two multiple sink placement strategies in WSNs which select the potential sink locations with an iterative manner is presented in the literature. Here, we introduce a lifetime-oriented approach (LOA) to maximize the average network lifetime and an energy-oriented approach (EOA) to minimize the average energy consumption of sensor network. Our existing algorithm proceeds iteratively and after a finite number of iterations, it produces the result which maximizes the average network lifetime (in lifetime-oriented approach) and minimizes the average energy consumption (in energy-oriented approach). In this paper, we propose a particle swarm optimization (PSO) based algorithm for placement of multiple sinks in WSNs. The performances of proposed system is evaluated and compared with previous approaches as LOA and EOA with the random sink placement (RSP) policy under various network scenarios. The experimental results show that the proposed algorithms prolong the average network lifetime and minimize the average energy consumption than LOA, EOA, and RSP.

1. Introduction

Wireless sensor networks (WSNs) consist of hundreds to thousands number of resource constraint sensors which have the capability to sense and monitor the region where they are deployed [1]. WSNs have drawn a significant attention in recent years in many applications, e.g., health care monitoring, disaster management, environment monitoring, object tracking, etc. One of the primary concerns of the sensor network is to minimize the energy usage of sensor nodes since sensors are often batteries operated. In [2], the authors introduced a dynamic routing technique for multi-hop wireless networks to minimize the energy burden at wireless node. In the cited approach, the authors focused on the wireless networks with a single sink. Here, the sink is responsible for gathering, analyzing, and forwarding the processed data to the cloud storage [9]. In [3], the authors proposed a single sink placement strategy, both in single and multi-hop WSNs to enhance the network lifetime. In a single sink WSNs, nodes nearer to the sink forward high-volume data traffic, deplete energy faster than the nodes which are away from the sink. This may lead uneven energy depletion among the nodes, and the network becomes disconnected soon. The unbalanced energy consumption does not only shorten the network lifetime, but also increases the network latency, number of retransmissions simultaneously. Under this paradigm, it is sensible to place multiple sinks to improve the network performance. In multiple sink WSNs, energy consumption is reduced, latency is minimized, and the lifetime of the network is prolonged [6]. However, the optimal sink placement is NP hard problem [8]. Several heuristics [4, 5] and meta heuristics [7, 8] approaches have been developed in the literature to address this problem.

2. Related work

In previous works [10], many people working on energy efficient sink placement strategies. So, they are specially two strategies taken named as Lifetime oriented approach (LOA) and Energy oriented approach (EOA) to maximize the average network lifetime and to minimize the average energy consumption of network, respectively. The algorithm has four phases, namely deployment phase, set up phase, potential sink location determination using LS and final sink location identification. In the deployment phase, nodes and sinks are deployed in the region randomly. In the setup phase, initial sink locations are chosen and grouping of nodes is done. In the third phase, local sink locations are explored so that the objective function is either maximized or minimized. In the last phase, final sink locations are identified. LOA and EOA work iteratively. At each iteration, we perform second and third phase, looking for the best solution.

3. Proposed system

In this paper, we propose a particle swarm optimization (PSO) based algorithm for placement of multiple sink in WSNs represented in figure 1. The algorithm is developed with an efficient scheme of particle encoding and novel fitness function. For the energy efficiency scheme of particle encoding and novel fitness function. For the energy efficiency of the proposed system, we consider various parameters such as Euclidian distance and hop count from the gateways to the sinks. The algorithm by varying the number of gateways and sensor nodes and the results are analyzed to show the efficiency of the proposed algorithm. PSO consists of a predefined number of particles say NP, called swarm. Each particle provides a potential solution. A particle P_i, $1<=i<=N_p$ has position $X_{i,d}$ and velocity $V_{i,d}$, $1<=d<=D$ in the d^{th} dimension of the search space. The dimension D is same for all paricles. A fitness function is used to evaluate each particle for verifying the quality of the solution. In the initialization process of PSO, each particle is assigned with a random position and velocity to move in the search space. During each iteration, each particle finds its own best, personal best called $Pbest_i$ and the global best called Gbest. To reach the global best solution, it uses its personal and global best to update the velocity $V_{i,d}$ and position $X_{i,d}$ using the following equations

$$V_{i,d}(t+1) = \omega \times V_{i,d}(t) + c_1 \times \boldsymbol{\chi_1} \times \left(X_{Pbest_{i,d}} - X_{i,d}\right)$$

$$+c_2 \times \boldsymbol{\chi_2} \times \left(X_{Gbest_d} - X_{i,d}\right) \quad (1)$$

$$X_{i,d}(t+1) = X_{i,d}(t) + V_{i,d}(t+1) \quad (2)$$

Where $0 < \omega < 1$ is the inertia weight, $c_1, c_2, 0 \leq c_1, c_2 \leq 2$ are the acceleration coefficients and $\chi_1, \chi_2, 0 < \chi_1, \chi_2 < 1$ are the randomly generated values. The updating process is repeated until it is reached to an acceptable value of $Gbest$. After getting new updated position, the particle evaluates the fitness function and updates $Pbest_i$ as well as $Gbest$ as follows

$Pbest_i = P_i$, if (Fitness(P_i) < Fitness($Pbest_i$))

$Pbest_i$, otherwise

Gbest = $Pbest_i$, if (Fitness($Pbest_i$) < Fitness(Gbest))

Gbest, otherwise

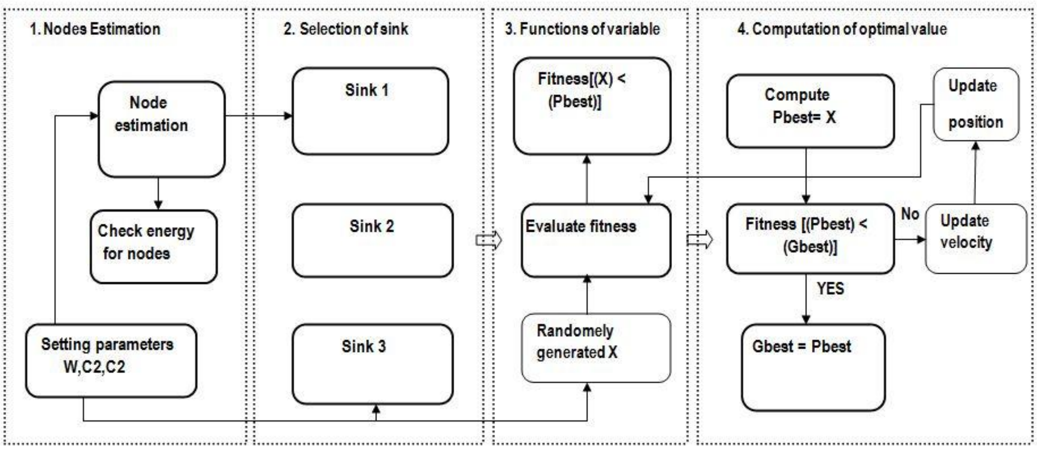

Figure 1. Update of multiple sink selection framework.

3.1. Particle representation and initialization:

In PSO, a particle represents a complete solution. For multiple-sink placement of the proposed algorithm, it represents optimal positions of the sinks with respect to the gateway nodes. Let $P_i = [X_{i,1}(t), X_{i,2}(t), X_{i,3}(t), \ldots X_{i,D}(t)]$ be the i^{th} particle of the population where each component $X_{i,d}(t) = (x_{id(t)}, y_{id}(t))$, $1<=i<=N_p$, $1<=d<=D$, denotes the coordinates of the sink nodes. Then the i^{th} particle can be represented as follows:

$$P_i = [(x_{i1}(t), y_{i1}(t)), (x_{i2}(t), y_{i2}(t)), (x_{i3}(t), y_{i3}(t)), \ldots\ldots, (x_{id}(t), y_{id}(t))]$$

Where N_p denotes the swarm of particles and D represents the number of sinks are supposed to be placed.

Algorithm

Input: set of gateway nodes: G= $\{g_1, g_2, g_3, \ldots, g_m\}$; predefined swarm size : N_p

Number of dimensions of a particle: D=l

Output: optimal positions of sink nodes SN = $\{SN_1\ SN_2\ SN_3 \ldots, SN_l\}$

Step 1: initialize particles P_i, i.j , $1<=i<=N_p$, $1<=j<=D=l$, number of SNs

$X_{i,j}(0) = (x_{i,j}(0), y_{i,j}(0))$ /* deployed positions of sink */

Step 2: for i=1 to N_p do

2.1 calculate fitness(P_i)

2.2 $Pbest_i = P_i$

End for

Step 3: Gbest = {$Pbest_k$/Fitness($Pbest_k$) = min(Fitness($Pbest_i$), 1<=i<=N_p)}

Step 4: for t=1 to Terminate /*Terminate = Max.number of iterations */

For i=1 to N_p do

4.1 Update velocity and position of P_i using eqs (1),(2)

4.2 Calculate Fitness (P_i)

4.3 if Fitness(P_i) < Fitness($Pbest_i$) then

$Pbest_i = P_i$

End if

4.4 if Fitness ($Pbest_i$) < Fitness(Gbest)

Gbest = $Pbest_i$

End if

End for

End for

End for

Step 5: stop

4. Result and discussion

Our experiments are conducted using the NS- 2.34 simulator. We conduct the experiments in two steps. The initial step is to check the viability of our plan, and then deeper study is investigation is done to assess the delay and throughput in more detail. In the first step, there are 43 mobile nodes in the network, and communication starts from source to destination. Here hop-to-hop communication occurs, and we can calculate the distance based on position of an individual node. The individual communication between user to user, numbers of data flows measured. None of the individual traffic rate goes beyond a certain threshold, but the sum of them does. Here we can know the transmission rate of every node based on residual energy. In our work, we can take multiple sinks for receiving the data and using our algorithm based on that best optimal path selection for sink placement. The best placement of sink can be helpful to more data can receive the data. The connections among mobile nodes are UDP connections, and we send CBR (Constant Bit Rate) traffic in each communication channel. The CBR rate of the connections is 512Kb/s. The size of the scenario field is 1000m x 1000m. The routing protocol we use is a revised AODV routing protocol that integrates our PSO-NL, EOA, LOA methods.

Table I: Simulation parameters

PARAMETER	VALUE
Application traffic	CBR

Transmission rate	8 packets/msec
Radio range	250m
Packet size	1000 bytes
Channel data rate	2Mbps
Maximum speed	25m/s
Simulation time	10secs
Number of nodes	43
Area	1000x1000
Routing protocol	AODV
Routing methods	EOA, LOA, PdSO-NL

Figure 2 demonstrate that end-to-end delay performance of proposed and existing approaches, and it depends on time to vary the output. The performance of the PSO-NL improves delay time which means decreasing the delay between the communication nodes as compared to ELOA and RSP approaches. Similarly, figure 3 and figure 4 discloses the performance graph of throughput and energy respectively where proposed PSO-NL approach obtained superior performance over RSP and ELOA approaches.

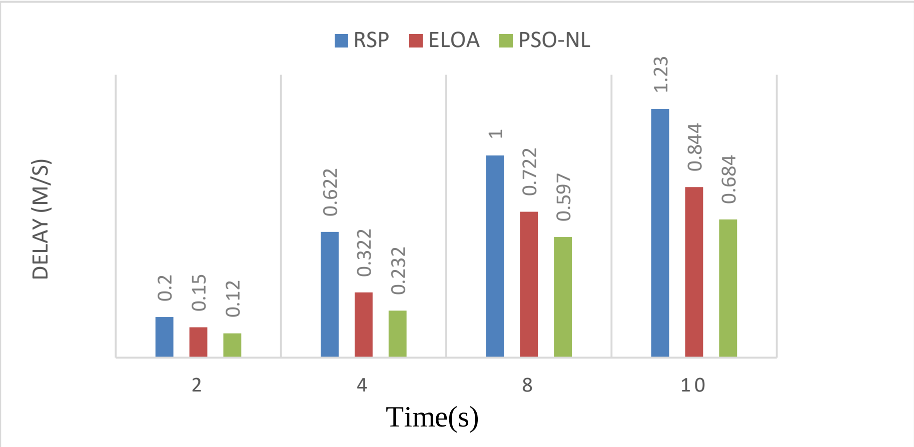

Figure 2: Routing delay

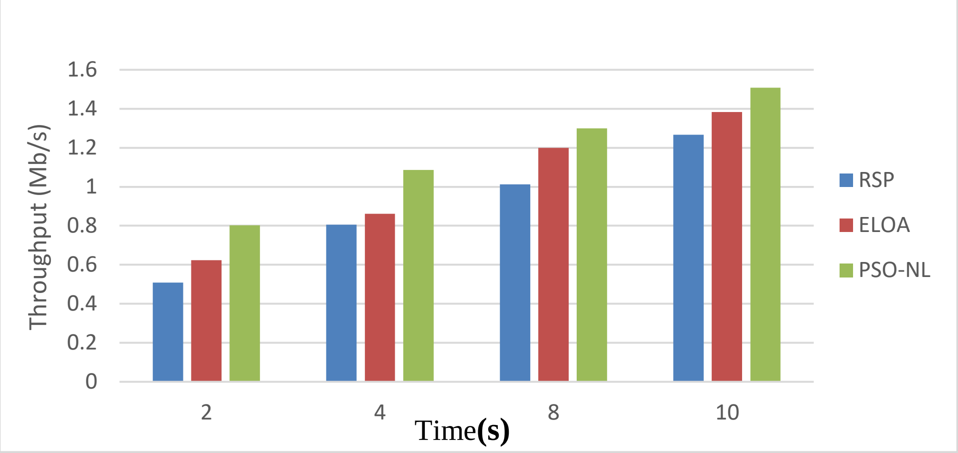

Figure 3: Network performance

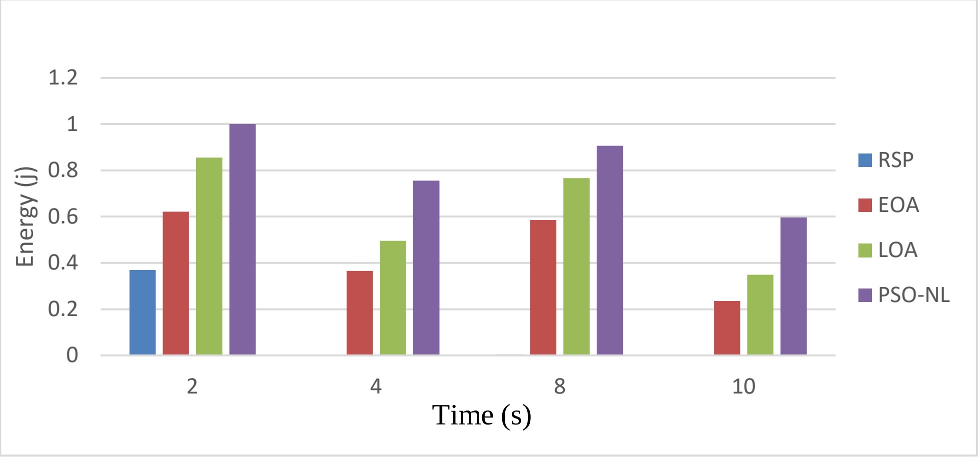

Figure 4: Energy consumption

5. Conclusion

This article proposed multiple-sink placement algorithm based on PSO using efficient particle representation and fitness function. For the energy efficiency of the proposed algorithm, we have considered the Euclidian distance and hop count. The objective of our PSO based sink placement approach is to improve the network lifetime with efficient energy levels to maintain in network. The proposed algorithms are simulated and compared with the EOA, LOA approaches and random sink placement algorithm with respect to various performance metrics. To show the improvement of PSO-NL with an existed exhaustive grid search algorithm, we have calculated network lifetime. It can be observed that the PSO-NL outperforms the existed algorithms.

References

[1] I. F. Akyildiz, W. Su, Y. Sankarasubramaniam, and E. Cayirci, “Wireless sensor networks: A survey,” Computer Networks, vol. 38, pp. 393-422, March 2002.

[2] S. Bhattacharjee, and S. Bandyapodhyay, “Lifetime maximizing dynamic energy efficient routing protocol for multihop wireless networks,” Simulation Modelling Practice and Theory, vol. 32, pp. 15-29, 2013.

[3] F. Chen, and R. Li, “Sink node placement strategies for wireless sensor networks,” Wireless Personal Communications, vol. 68, pp. 1-17,2013.

[4] L. Sitanayah, K. N. Brown, and C. J. Sreenan, " Multiple sink and relay placement in wireless sensor networks," in: Proceedings of the 1st Workshop Artificial Intelligence for Telecommunications and Sensor Networks, 20th European Conference on Artificial Intelligence, 2012.

[5] X. Xu, and W. Liang, "Placing optimal number of sinks in sensor networks for network lifetime maximization," in: Proceedings of IEEE International Conference on Communications (ICC), 2011.

[6] P. Chatterjee, and N. Das, "Multiple sink deployment in multi hop wireless sensor networks to enhance lifetime," in: Proceedings of IEEE International Conference on Applications and Innovations in Mobile Computing (AIMoC), 2015.

[7] H. Safa, W. El-Hajj, and H. Zoubian, "Particle swarm optimization-based approach to solve the multiple sink placement problems in WSNs," in: Proceedings of IEEE International Conference on Communications (ICC), 2012.

[8] C. S. Rao, H. Bank, and P. K. Jana, "PSO-based multiple sink placement algorithm for protracting the lifetime of wireless sensor networks," in: Proceedings of 2nd International Conference on Computer and Communication Technologies, 2016.

[9] S. Mao, "Crowd cloud routing based on opportunistic computing for wireless sensor networks," EURASIP Journal on Embedded Systems, vol. 2016, pp. 25, 2016.

[10] S. Bhattacharjee, K. Agrwal, "Energy efficient multiple sink placement in wireless sensor networks', 978-1-5386-3288, IEEE, 2017.

