IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Volume-6, Issue-2 E-ISSN: 2347-2693

An Updated Particle Gaggle Based Optimization Routing Algorithm for Wireless Sensor Networks

M.A. Mukib [1*], L. B. Mahabub [2], M. A. Rahman [3]

[1*]Department of Computer Science and Engineering, Hamdard University Bangladesh, Munshiganj, Bangladesh
[2] Department of Computer Science and Engineering, Hamdard University Bangladesh, Munshiganj, Bangladesh
[3] Department of Computer Science and Engineering, Hamdard University Bangladesh, Munshiganj, Bangladesh

Corresponding Author: mukib.hub@gmail.com, Tel.: +880-1912719224

Available online at: www.ijcseonline.org

Received: 31/Jan//2018, Revised: 06/Feb2018, Accepted: 14/Feb/2018, Published: 28/Feb/2018

***Abstract*—** the wireless sensor network is a largely growing research field in the recent world. This network has a vast area of implementation now and is gradually increasing day by day. The main use of the wireless sensor network technology is in the environment system, the object tracking system, sensing data from the location where human can't reach etc. A sensor network is a combination of low-cost sensor devices with a limited range of data transmission and battery power. A sensor node is responsible to collect sensed data and send those data to the base station and the base station processes those data. Normally a sensor network requires a fixed amount of energy to collect a bit of data. The battery use of the sensor nodes depends on the data collected and transmitted to the base station and also the data transmission range. So, it is very difficult for a sensor network to send data directly to the base station as some sensor nodes may be placed at a long distance from the base station. Then to send data to the base station will finish all its power and the node will die soon. This is the reason the sensor nodes use the clustering technique where the nodes send data to its cluster head and the cluster head forwards data as a tree structure to the base station. This assures a better lifetime of the sensor devices. Some common well known lifetime optimization algorithms are- LEACH, LEACH-C, PEGASIS, GROUP, Ant Colony etc [1]. In this paper, we have proposed an Updated Particle Gaggle Optimization based Routing protocol (UPGOR) where energy efficiency of the sensor nodes is the major focus for the routing protocol and finding an optimized path for data forwarding to the base station and data processing through the base station. The UPGOR algorithm takes the energy as the fitness and finds an optimized path among several available paths to route data. At the end of this paper, we compared our simulated experimental results with other relevant algorithms which show a better result obtained by the proposed UPGOR algorithm. The simulation is done in the NS2 simulation in Ubuntu environment and the simulated data then placed to generate the tables and charts.

Keywords— *Particle Gaggle Optimization, Routing, Lifetime, Wireless Sensor Network, Energy Efficiency*

I. Introduction

In the recent wireless sensor network advancement, computing and communication technologies coupled with the need to continuously monitor physical phenomena have led to the development of Wireless Sensor Networks (WSNs). The major components of the wireless sensor network are- A radio, a processor, sensors, and battery. A WSN is generated by densely deployed sensor nodes in an application area from where the sensed data should be collected for processing. In most deployments, the sensor nodes have self-organizing capabilities, to generate a structure and perform a predefined task altogether. Wireless Sensor Networks (WSNs) is a class of wireless ad hoc networks in which sensor nodes collect, process, and communicate data acquired from the physical environment to an external Base Station (BS). The sensor nodes are only responsible for sense data and forward those data to the base station. The key constraints in the development of WSNs are limited battery power, cost, memory limitation, limited computational capability, and the physical size of the sensor nodes. Due to the severe energy constraints of a large number of densely deployed sensor nodes, it is important to have a proper routing protocol for the sensor nodes to route data in a structured way to save the battery power and also assure the data security. Wireless Sensor Networks are found suitable for applications such as surveillance, precision agriculture, smart homes, automation, vehicular traffic management, war area, underwater data collection, deep forest data collection, disaster detection etc. Routing in wireless sensor networks differs from conventional routing in fixed networks in several ways like- there is no infrastructure, wireless links are unreliable, sensor nodes may fail, and routing protocols have to meet strict energy-saving requirements.

General routing algorithms have some limitations when they are applied to the wireless sensor networks, the main limitations are the battery lifetime of the sensor nodes as well as the network. In this research, we tried to solve this issue and tried to increase the lifetime of the sensor networks. Besides maximizing the lifetime of the sensor nodes, it is preferable to distribute the energy dissipated throughout the wireless sensor network in order to minimize maintenance and maximize overall system performance while routing [2]. In the sensor networks, it is not mandatory for each node to save a fixed energy, sometimes, the shortest path might take a huge amount of energy which may cause a permanent failure of the network. So, it is required to take both the energy efficiency and the distance as the major criteria for selecting an optimized path of routing.

II. Related Work

The network lifetime increment is a primary issue in the wireless sensor network. It is important to provide the best network solution to achieve the best lifetime from the sensor nodes. In this area of research, several researchers are working to improve the network lifetime and energy efficiency of the sensor network. A very renowned similar routing algorithm designed by the Seluck Okdem named the Ant Colony algorithm to solve the lifetime problem of the sensor nodes. Some common sensor network systems like the asymmetric traveling salesman, vehicle routing, and WSN routing uses this Ant Colony Optimization [3, 4, 5] routing protocol algorithm. Another similar algorithm designed by Singh which does not follow the structure of WSN's energy-related issues. Then Zhang proposed the ant-based algorithms named SC, FF, and all FP. All three algorithms have a very good startup but the SC and FF have some latency problems while giving best battery service. The FP algorithm uses more battery than the other two while giving high success rate of data delivery to the base station. The Energy Efficient Ant-Based Routing Algorithm (EEABR), based on the Ant colony theory, another ant based technique to enhance the battery lifetime of a wireless sensor node. This algorithm uses the energy and a route of the sensor nodes to deliver data as the main parameter. Heinzelman focused on the energy efficiency of the wireless sensor nodes and designed a cluster based routing algorithm so that the sensor nodes can send data to the cluster heads instead of the base station directly [6]. The cluster heads then forward those sensed data to its upper-level cluster head and this process will continue until the data reaches the base station. The sensor node acting as the cluster head will have more energy than the other sensor nodes of that network [11]. This algorithm is renowned energy-efficient algorithm named LEACH [6] and its updated algorithm is LEACH-c. Another very good algorithm for energy efficiency is Power-Efficient Gathering in Sensor Information Systems (PEGASIS) [7]. This is considered as the optimization of the LEACH algorithm as it improves the LEACH algorithm and shows a better result than the LEACH [8]. With the clusters, the PEGASIS algorithm makes a chain with the sensor nodes which assures the success of data to be sent to the base station. This is the technique where the nodes will get data to the closest sensor nodes and it will reduce the power dissipation. In the chain of the network, each node will work as the head to transmit data in each round. Ayan Chakraborty proposed the Genetic Algorithm (GA)[9] which gives enhanced battery performance and increases the network lifetime.

In this research, we are going to propose a new algorithm named "Updated Particle Gaggle Optimization based Routing protocol (UPGOR)". This algorithm is designed to increase the network lifetime by decreasing the battery dissipation of the sensor nodes. This algorithm uses the energy level of the nodes and the routing path distance as its parameter. This paper compared the proposed system with ACO, and GA algorithm and this shows that the proposed algorithm is somewhere better compared with those algorithms. The main focus of this research was to increase the network lifetime at the maximum while finding the shortest path and uses the gaggle technique to reach in the destination. The result achieved by the UPGOR algorithm shows encouraging development over the GA, PEGASIS, LEACH, LEACH-c, and ACO algorithms. The UPGOR algorithm was designed and implemented in the NS-2 simulator [10] for Ubuntu platform.

III. Methodology

The Updated Particle Gaggle Optimization Routing (UPGOR) algorithm is the algorithm that uses the computational method which works iteratively to solve a problem and improve the result. This is the method where the sensor network selects the best path among several selected paths which uses optimized battery use and increases the network lifetime. The shortest path selection will assure minimum energy requirement to enhance the lifetime of the node and network. As this research is working with the energy efficiency, the more distance will require more energy. So, UPGOR is used to calculate the fitness value and preparing the best path to route data to the base station.

Fitness Function:

In UPGRO algorithm, first, it requires the fitness value to find the optimized path of data transmission. This is important to find the local best and the global best path to route data. The fitness function is used for this purpose. The optimized path will be the path that has the minimum fitness value. The equation used for calculating the fitness value is:

Fitness value=dist(i,j) + dist (j, base station) (1)

Here i, j are the distance of the node.

Representation:

The path generation is the focus of the UPGOR algorithm. It is easier to use the natural number system in the algorithm to find the shortest path. This research uses the shortest positioning index for making the position of the sensor nodes simple and easy to calculate. In this method, the values are sorted first from minimum to maximum according to the position.

Example: The data [0.915, 0.465, 3.56, 2.153, 1.55] will be look like [2, 1, 5, 4, 3] after implementing the sortest positioning index.

The Algorithm:

Updated Particle Gaggle Optimization Based Routing
Phase 1: [Initialization Phase]
start loop
for (s = 0 to N). // N is the number of solutions
for (d = 0 to n).// n is the number of sensor nodes
Randomly solutions are selected.
Compute new optimized route using the best solution.
End loop
Start loop
Compute fitness value of the initialized solution.
Compute global best
Compute Local best.
End loop
Phase 2: [Update Phase]
Start Loop
While criteria does not match
for (s = 1 to ns) // ns is the number of solutions
for (d = 1 to n). // n is the number of sensor nodes
update solution using UPGRO update equation.
Generate new path based on update solution.
End loop.
Start loop
Compute fitness value for the updated route.
Compute global best
Compute local best.
End loop.
Point the global best path
End loop.

This paper used the UPGRO algorithm to find the best-optimized path that uses less energy to send data to the destination successfully. There are several probable sets of solutions available for the route. If x is the total number of solutions, then a set of x! will be the set of probable solutions. As the initial random solutions are ready, this research calculates the fitness value of each solution according to the equation number 1. After the calculation of the fitness value, this paper selects this solution as the global best and local best selection and process for further processing and further calculation to find whether this is the optimized solution or there the more optimized solution available using this algorithm. Then the UPGRO algorithm is used to update the solution and find out a newer solution if available or place the existing solution as the final solution. This is a continuous process and will continue until all the nodes are used to calculate. After all the calculation, the final solution will take place and will be used to route data to the base station to save the energy dissipation and increase the network lifetime.

IV. RESULTS AND DISCUSSION

In this research, the network simulator 2 (ns-2) in the Ubuntu platform to simulate the existing algorithms as well as the proposed algorithm. To simulate the algorithms, 50 sensor nodes were deployed onto a 100 x 100m2 grid area shown in fig 1. The UPGOR algorithm was simulated in the ns-2 simulator and the code was written in the OTcl programming language.
The next part of the paper will show the experimental results of the proposed UPGOR algorithm and its comparison with the Genetic Algorithm and ACO algorithm.

Experimental Setup:

For doing an efficient work, it requires some control parameter to simulate each algorithm. The first parameter used in this research is the maximum number of solutions and this research selects 30 as the maximum solution. The next parameter is the number of sensor nodes and this research used 100 sensor nodes to simulate the proposed and other algorithms. The next parameter is the number of iteration statements used in the simulation. This research selects 9000 iterations as its parameter. The next parameter is the number of random solutions and in this research, as it is using 100 nodes; it requires 100 possible random solutions for the simulation. The comparison was done with the Genetic Algorithm and the ACO algorithm to show the performance of the UPGOR algorithm. The experimental results are shown below:

Experimental Results:

Table 1: Fitness value calculated by using UPGOR and comparison with GA and ACO varying number of nodes

No. of Nodes	20	40	60	80	100
GA	5136.21	8345.23	10290.25	14012.65	17890.45
ACO	4532.26	6325.23	8652.36	11325.75	15152.11
UPGOR	3720.18	4512.32	6523.12	7452.12	10120.25

The table shows that the UPGOR algorithm works a little bit better than the other two comparative algorithms named GA and ACO. For 20 - 100 nodes, the fitness value using the UPGOR algorithm is less than the fitness value found by using GA and ACO algorithms that assures more battery lifetime of the sensor nodes.
Here, the UPGOR is compared with the GA and ACO algorithm based on the fitness value. The simulation chart is shown below:

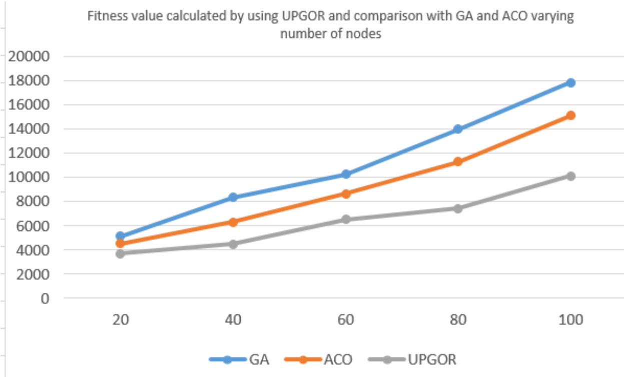

Figure 1: Fitness value calculated by using UPGOR and comparison with GA and ACO varying number of nodes

Table 2: Fitness value calculated by using UPGOR and comparison with GA and ACO varying number of iterations

Iteration	1500	3000	4500	6000	7500	9000
GA	5606.07	6533.35	7512.12	8475.54	9142.35	9545.22
ACO	4812.12	5412.35	6012.32	6751.12	7012.35	7324.48
UPGOR	4823.93	4280.07	4280.08	4145.32	4135.11	4122.17

This table shows the fitness value comparison depending on the number of iteration operations. For a number of iteration operations, the UPGOR algorithm finds less fitness value compared with GA and ACO algorithms which assure less energy dissipation and increment of lifetime. This comparison is shown by using a line chart below:

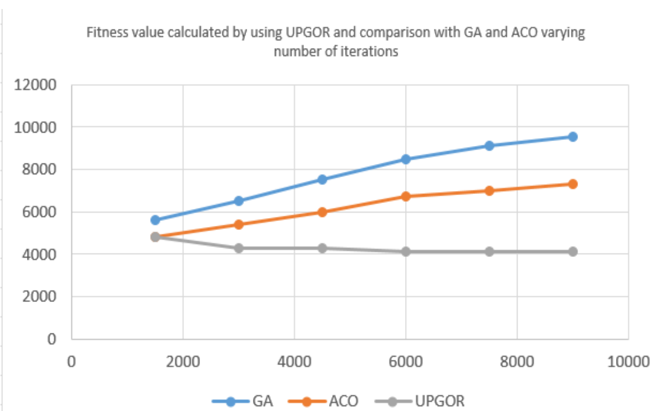

Figure 2: Fitness value calculated by using UPGOR and comparison with GA and ACO varying number of iterations

Table 3: Fitness value calculated by using UPGOR and comparison with GA and ACO varying number of random solutions

Random Solutions	25	50	75	100
GA	6432.24	6812.35	6912.54	7112.45
ACO	5674.34	6751.21	6514.12	6214.12
UPGOR	4497.21	5012.32	4687.85	4785.35

This table compared the UPGOR algorithm based on varying the number of random solutions. In this table it is also clearly visible that the performance of UPGOR is better than GA and ACO algorithms. The line comparison of this table is shown below:

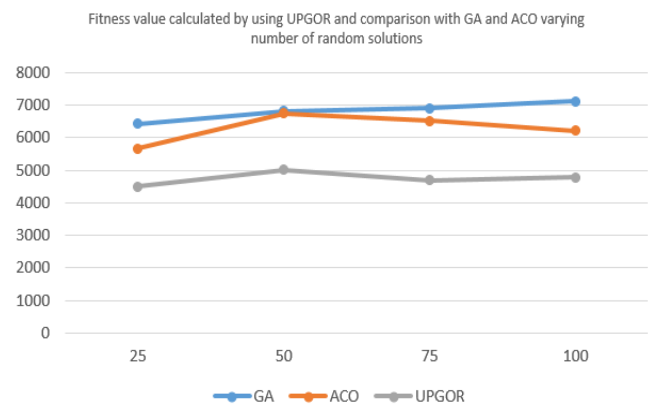

Figure 3: Fitness value calculated by using UPGOR and comparison with GA and ACO varying number of random solutions

Discussion:

From the table 1, 2, and 3 it can be said that the proposed UPGOR algorithm will provide a better result than the GA and ACO routing algorithm and will save energy dissipation as well as increase the network lifetime of the sensor network. The parameters used to simulate the algorithms are the standard parameters and used all over the world in research of this topic. So, it can be concluded that the proposed algorithm is better than the others and can increase the network lifetime.

V. CONCLUSION and Future Scope

This paper proposed a novel algorithm to enhance the network lifetime and reduce the energy dissipation of sensor nodes. The concept of this algorithm was, the greater distance will require greater energy to transmit data. So the data should be transmitted in such a way that the path is optimized and energy requirement will be optimized too. So the shortest path selection is required. The algorithm is completed by the concept of UPGOR. The simulation results show that the proposed algorithm shows better performance than the GA and ACO routing algorithm to achieve less fitness value that can assure more battery lifetime of the sensor nodes. The simulation is done to calculate the fitness value by using different parameters. The parameters used to calculate the fitness value are the number of sensor nodes, the number of iteration operations and varying the number of random solutions. In all the scenarios, the UPGOR algorithm achieves less fitness value and made the research successful to achieve more battery lifetime that increases the lifetime of the network. In future, the UPGOR algorithm can be updated more to reduce more energy dissipation so that the network lifetime will increase more for a wireless sensor network. This may work better than the proposed algorithm in future.

REFERENCES

[1] N. Jamal, *"Routing techniques in wireless sensor networks a survey,"* IEEE Wireless communication, Vol 11(6), 2012

[2] S. K. Singh , M. P. Singh , and D. K. Singh, *"Energy Efficient Homogenous Clustering Algorithm for Wireless Sensor Networks"*, International Journal of Wireless & Mobile Networks (IJWMN), Vol.2, No.3, August 2010.

[3]S. Okdem and D. Karaboga, Routing in Wireless Sensor Networks Using an Ant Colony Optimization (ACO) Router Chip In *Sensors",* 2009.

[4] Z. Luo, L. Lu, J. Xie, J. He, *"An ant colony optimization-based trustful routing algorithm for wireless sensor networks,"* in 2015 4th International Conference on Computer Science and Network Technology (ICCSNT), pp. 1128–1131, IEEE, dec 2015

[5] R. Arya, S.C. Sharma, *"Analysis and optimization of energy of sensor node using ACO in wireless sensor network,"* Elsevier B.V, Vol. 45, pp. 681-686, 2015

[6] W. B. Heinzelman, A. P. Chandrakasan, H. Balakrishnan,*"An Application-Specific Protocol Architecture for Wireless Microsensor Networks"*, IEEE Trans. Wirel. Commun. 2002, 1, 660–670.

[7] S. Lindsey, C. S. Raghavendra, "PEGASIS: Power-Efficient Gathering in Sensor Information Systems", In Proceedings of the Aerospace Conference, Big Sky, MT, March, 2002; pp. 1125–1130.

[8] Y. Zhang, L. D. Kuhn, and M. P. J. Fromherz, "*Improvements on Ant Routing for Sensor Networks*", M. Dorigo et al. (Eds.): ANTS 2004, Springer-Verlag Berlin Heidelberg 2004, vol. LNCS 3172, pp. 154-165, 2004

[9] A. Chakraborthy, S. K. Mitra, M. K. Niskar, *"A Genetic Algorithm Inspired routing Protocol for Wireless sensor Network",* in International Journal of Computational Intelligence Theory and practice, Vol 6 No.1 June 2011

[10] S. Mccanne, S. Floyd, and K. Fall, *"Network Simulator 2 (NS-2) version 2.35,"* in http://www-nrg.ee.lbl.gov/ns/, http://www.isi.edu/nsnam/ns (1998)

[11] P. Rani, A. Gupta, Y. Singh, "*Multiple Event Detection In Wireless Sensor Networks Using Compressed Sensing: Health Monitoring Perspective* ", in International Journal of Computer Science and Engineering, vol.6 , Issue.1 , pp.36-41, Jan-2018

Authors Profile

M. A. Mukib pursed Bachelor of Science from American International University- Bangladesh (AIUB), Bangladesh in 2012 and Master of Science from same institute in 2018. He is currently working as Lecturer in Department of Computer Science and Engineering under Faculty of Science, Engineering and Technology, Hamdard University Bangladesh, Bangladesh since March 2014. He has published 4 research papers in reputed international and national journals including IJCA, IJCSE, IJLERA. His main research work focuses on Routing path optimization, Enhancing battery lifetime of wireless sensor network, Cryptography Algorithms, Network Security, Cloud Security and Privacy, Big Data Analytics, Data Mining, IoT and Computational Intelligence based education. He has 6 years of teaching experience.

L. B. Mahabub pursed Bachelor of Science from the Dhaka City College under the National University, Bangladesh in 2014 and Master of Science from Jahangirnagar University, Bangladesh, in year 2016. She is currently working as Lecturer in Department of Computer Science and Engineering under Faculty of Science, Engineering and Technology, Hamdard University Bangladesh, Bangladesh since January 2017. Her main research work focuses on Routing path optimization, Enhancing battery lifetime of wireless sensor network, Cryptography Algorithms, Image Processing, Data mining. She has more than 2 years of teaching experience.

M. A. Rahman pursed Bachelor of Science from the Rajshahi University of Engineering and Technology (RUET), Bangladesh in 2016. He is currently working as Lecturer in Department of Computer Science and Engineering under Faculty of Science, Engineering and Technology, Hamdard University Bangladesh, Bangladesh since May 2017. His main research work focuses on Image Processing, Artificial Intelligence, Routing path optimization, Enhancing battery lifetime of wireless sensor network, Cryptography Algorithms, Data mining. He has almost 1 year of teaching experience.