New technique for Sensors arrangement in WSNs

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***Abstract:**Wireless sensor networks (WSNs) are considered the basis of all architectures in IoT applications. These networks are deployed according to the needs of each domain. The goals of the proposed approaches of deployment are the lifetime maximization of each device. The major challenge is to find a tradeoff between the desired requirements for the lifetime, coverage, and cost with limited available resources. In this paper, we present a new method for the deployment of WSN that tries to increase the lifetime of the network. A set of optimum positions are presented after their calculation using a GPS. The objective is to locate our sensors in these optimum positions. We try to minimize the energy consumption by decreasing the distance travelled by the sensors to reach their optimum positions.*

***Index terms:**WSNs, IoT applications, deployment problems, lifetime, and energy consumption.*

I. INTRODUCTION:

The region of all objects in the world is actually based on IoT applications. These applications concern many types of supervision. The need to observe and control physical phenomena such as temperature and pressure is essential for industrial and scientific applications. This task is delegated to sensors whose function is to acquire information about the observed phenomena and execute the processes attached to it. WSNs are considered a special type of ad hoc network. They bring forth an interesting perspective: Those networks can self-configure and manage themselves without the need for human intervention. The nodes are typically deployed randomly throughout a geographical area, called the area of interest. The collected data is routed through wireless communications to a base station whose role is to aggregate and to exploit the data collected [1].

In WSNs, the sensors have limited resources, energy resources and generally the computer capacity and storage capacity. Therefore, most studies and research on WSNs have focused on optimizing resources to improve performance and meet the quality of service (QoS) requirements. Researchers are working on the determination of the sensor field topology because it has a great influence on the performance of WSNs. It also affects the QoS metrics, such as energy consumption, sensor lifetime, and sensing coverage [2]. In the literature, several studies have proposed approaches to locate a WSN. Evolutionary algorithms (EAs) are well suited to adapt the behavior of many adaptive systems because of their simplicity [1]. EAs require only a fitness function to provide a measure of the systems‟ behavior. Many variations of EAs for adaptive systems‟ behavior have been extensively explored. The paper is organized as follows: the next section provides a number of deployment approaches applied in various applications. In the second section, we present our proposed approach for sensor deployment. The simulation results and discussion are given in section three. We conclude the paper in the last section

II. RELATED WORK

The process of deploying nodes directly affects the performance of WSNs. The problem of deploying or positioning sensors is the strategy used to define the network topology, number, and position of the sensor nodes. Researchers aim to achieve an optimal deployment that increases the coverage rate and network lifetime with a minimization in the energy consumption. In this context, many approaches have been proposed in the literature.

A. Particle swarm optimization

Particle swarm optimization has been used by several researchers in the deployment of sensor networks. Enami et al. [3] proposed a mixture of stationary and mobile nodes, and they used particle swarm genetic optimization (PSGO) as a solution to cover the holes. PSGO is used to determine the redeployment positions of the mobile nodes to improve the average density of the nodes. PSGO maximizes the quality of service, which is defined as the ratio of the covered area to the total area. In a previous study [4], the researchers proposed a new method to optimize the coverage rate using the “Voronoi diagram” and the PSO. The PSO is used to find the optimal positions of the sensors to maximize the coverage, and the “Voronoi diagram” is used to evaluate the objective function value of the solution. The execution time depends on the number of sensors in the network.

B. Genetic algorithm

Several studies have focused on the problem of deploying nodes to get maximum coverage in WSNs. Genetic algorithms have also been used to solve the problem of optimal node deployment. While most of the proposed solutions have focused on the deterministic deployment of nodes, little work has been performed in the case of random node deployment [5]. The researchers used “Voronoi diagrams” to devise the field into cells. Then, the AGs were applied to determine the best positions for k additional mobile nodes that maximize the area coverage within each cell. Some research used the AG to search for an optimal number of sensor nodes that can be added after the node's initial deployment (random deployment) to maximize coverage [6].

C. Flower pollination optimization

The main challenge of WSNs is to optimize the performance of the sensor nodes to save energy and thus, extend the network lifetime. To achieve this objective, the researchers proposed to apply a “clustering” algorithm based on FPA [7] [8]. Hajje et al. [9] proposed an approach based on FPA. The goal of MOFPA is to find optimal sensor positions in an area taking into account coverage rate, energy consumption and connectivity. FPCOA is the approach presented in another study [10]. It is based on FPA. The authors aim was to find a better network topology whose main objective is to maximize the coverage of the area. Hajjej et al. [11] tried to find an optimal tradeoff between maximum coverage, reduced energy consumption, improved network lifetime, and the maintenance of the connectivity.

III. PROPOSED APPROACH

In WSN applications, the great challenge is to guarantee the long lifetime of the sensor nodes [8]. This leads us to discover new horizons to reduce the energy consumption. Consuming less energy is a primary objective when designing WSN applications, as each sensor node is usually supported by batteries, which may be difficult to replace [12]. The initial phase includes starting the network. A set of mobile sensors are placed randomly in the area of interest and these sensors have the same initial energy (homogenous network). On the other side, the optimal positions, found in the given area, are given from the beginning and are calculated as a function of coverage so they achieve a maximum coverage. A satellite is used to determine these optimum positions [13].

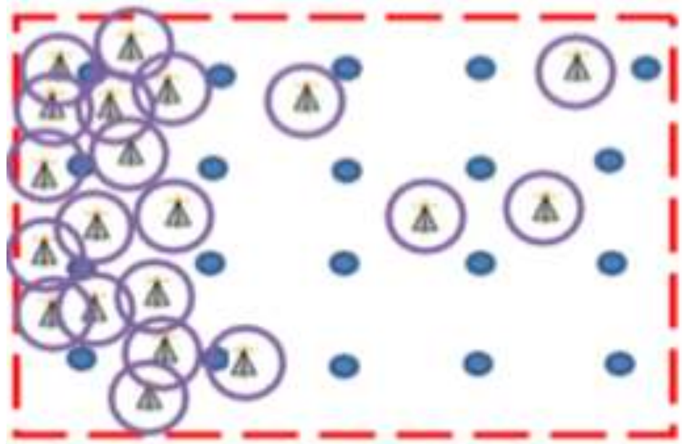

Fig. 1. Initialization phase.

The initial phase of our algorithm involves the following steps: Random deployment of sensors (See Fig. 1).The base station collects the locations of all sensors. These can perform a self-localization and send their locations to the base station. The base station uses this information to affect sensors to optimum positions using our approach that will be explained after. To determine the position of each sensor, the process illustrated in Fig. 2 is followed. The base station sends the new topology to the sensors and these will moved according to it.

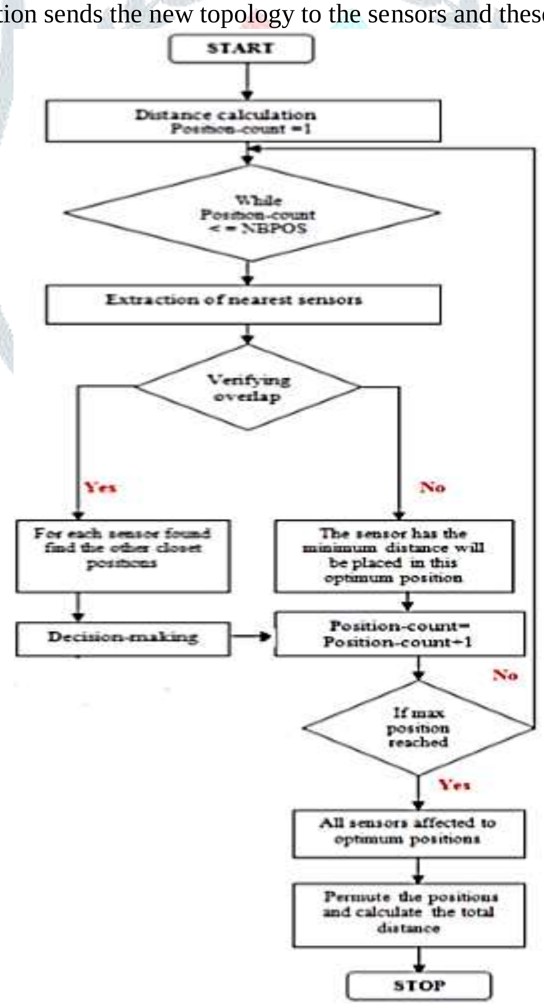

Fig. 2. The flow chart of the proposed approach.

To situate the sensors in their optimum positions, a set of steps presented in the flowchart will be followed. The optimal positions ensure a maximum coverage; thus, placing all the sensors in these positions guarantees coverage equal to 100%. The objective is affecting sensors in these positions with reduced energy consumption to extend the network lifetime.The flowchart of the proposed approach is given in Fig. 2.The first step is to calculate the distance between each position and sensor (Euclidian distance). Then, for each position, we will extract the nearest sensor (which has the minimum distance).

To verify the overlap we look for the other sensors with the same minimum distance: two cases may be found. The first is when there are no other sensors with the same minimum distance so the nearest sensor will be affected to this current position. The second case is when we found other sensors having the same minimum distance. We look for each sensor found if there is another position closer than the current position.

In the decision-making step, we will affect to the current position, the nearest sensor that does not have another position closer than the current position. If all the sensors found have other positions closer than the current position, we select a sensor randomly to assign it to this position. If all the sensors are assigned, the positions of the sensors will be swapped and the total distance traveled by the whole network will be calculated each time. The topology that gives the shortest distance will be followed.

IV. RESULTS AND DISCUSSION

We evaluated our approach using the parameters presented in the following table:

TABLE I: INITIALIZATION PARAMETERS

Width of area	100 m
Height of area	100 m
Number of deployed sensors	15 sensors
Number of optimum positions	15 positions
Rs	15 m
Rc	15 m

As mentioned previously, a set of optimal positions were initially determined. The figure shows the location of the optimal positions in the area of interest.

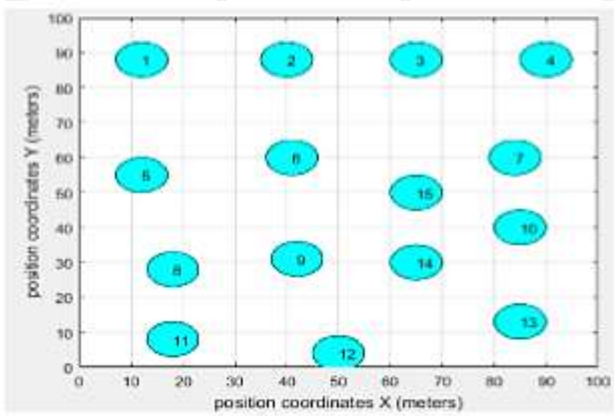

Fig. 3. The locations of the optimum positions.

Initially, the sensors were deployed in the area randomly. This causes cover holes. As shown in Fig. 4, the random distribution of the sensors does not guarantee the coverage of the entire area.

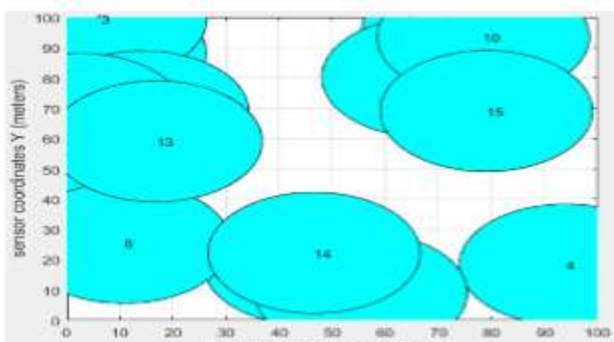

Fig. 4. Random sensor distribution

The application of our deployment approach gives the following topology with the distances traveled by the sensors to reach their positions. The topology obtained is presented in Table II with the distance traveled by the sensors. Using this distribution we aimed to balance the distances traveled by the various sensors. Therefore, the energy dissipated will be equitable for all the sensors. Before placing a sensor in an optimal position, we have taken into account the current positions of all the sensors. Fig. 5 shows the deployment of the sensors in the zone of interest by following the obtained topology.

TABLE II: THE DEPLOYMENT RESULTS OF PROPOSED APPROACH

Optimum position	Affected sensor	Distance (position, sensor)
Position 1	Sensor 3	4.0158
Position 2	Sensor 10	18.0938
Position 3	Sensor 6	10.8652
Position 4	Sensor 15	29.3200
Position 5	Sensor 13	12.2550
Position 6	Sensor 11	16.8478
Position 7	Sensor 7	15.2106
Position 8	Sensor 8	2.4234
Position 9	Sensor 1	15.0067
Position 10	Sensor 4	46.9296
Position 11	Sensor 5	9.6338
Position 12	Sensor 9	20.9829
Position 13	Sensor 12	12.1744
Position 14	Sensor 2	13.0349
Position 15	Sensor 14	15.2277
Total distance travelled by all	**242.0215**	

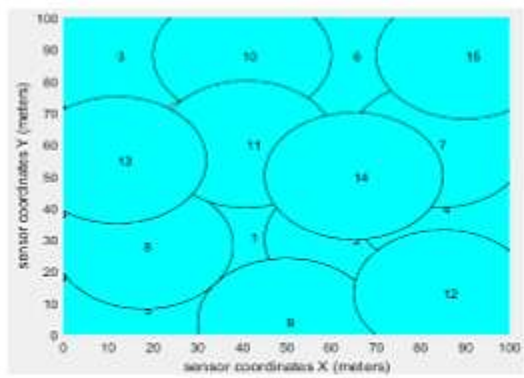

Fig. 5. The new sensor distribution using the proposed approach.

We compared the coverage of the area of interest after the new distribution with that of the initial distribution (random distribution) (Table III).

TABLE III: THE INFLUENCE OF OUR APPROACH ON THE COVERAGE OF THE AREA OF INTEREST

Initial distribution	67%
Proposed approach	100%

We noted that after the random sensor deployment, the area was not fully covered. The coverage rate reaches 100% by applying our proposed approach. We now concentrated on the comparison of the new approach with some of the existing algorithms reported in the literature.

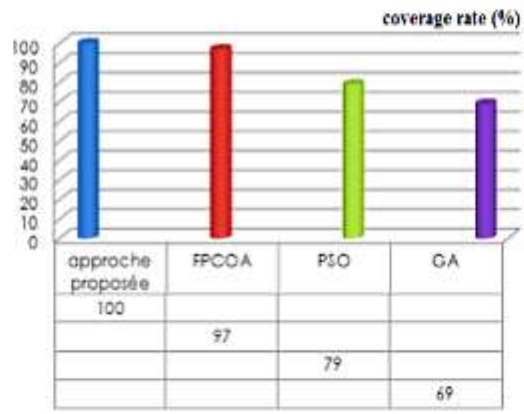

Fig. 6. The performance of the proposed approach.

By comparing our approach with some of the existing algorithms [6], we assume that it is efficient in terms of coverage. Because we have determined the optimal positions from the beginning, the location of the sensors at these positions is considered the best. The minimization of deployment cost is also considered one of localization algorithms objectives in WSNs. The aim is to achieve a maximum coverage rate using a small number of sensors. As long as the number of sensors decreases, the deployment cost will also be minimal. We compared our approach with some of the existing approaches [5]. The following flowchart shows the variation in the coverage rate as a function of the number of sensors deployed in the area.

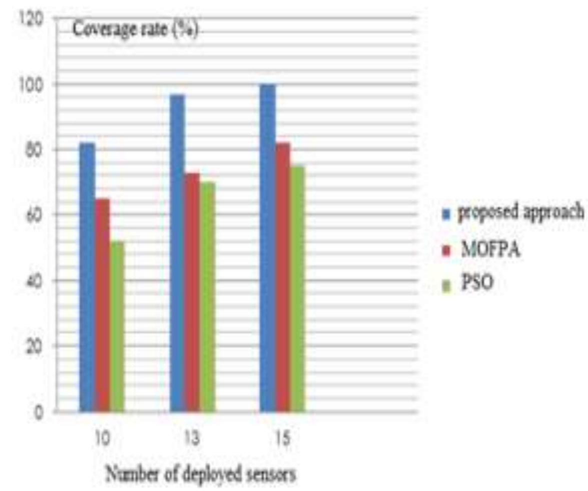

Fig. 6. The variation in the coverage rate as a function of the number of deployed sensors.

From the graph above, we find that our approach gives good performances by varying the number of sensors deployed. By comparing it with MOFPA and PSO, the area of interest is more covered when we apply our approach.

V. CONCLUSIONS

This paper proposes a method to optimize the deployment of WSNs by finding a tradeoff between the desired requirements for the lifetime, coverage and cost with limited available resources. The proposed approach tries to increase the lifetime of the network. We tried to minimize the energy consumption by minimizing the distance travelled by the sensors. In a future work, we will apply our approach to a heterogeneous network with an inequality between the number of sensors to affect and the optimum positions.

REFERENCES

[1] B. K. Ashton. (June 2009). That „Internet of Things" Thing. In the real world, things matter more than ideas. RFID Journal. [Online]. Available: http://www.rfidjournal.com/articles/view?4986

[2] C. Y. Chong and S. P. Kumar, "Sensor networks: Evolution, opportunities, and challenges," Proceedings of the IEEE, vol. 91, no. 8, pp. 1247-1256, August 2003.

[3] N. Enami and R. A. Moghadam, "Energy based clustering self-organizing map protocol for extending wireless sensor networks lifetime and coverage," Canadian Journal on Multimedia and Wireless Networks, vol. 4, no. 1, pp. 1-13, August 2010.

[4] N. A. Saadi, "Multi-objective wireless sensor network deployment," Ph.D. dissertation, Pierre &Mariecurie University.

[5] S. M. Hosseinirad and S. K. Basu, "Wireless sensor network design through genetic algorithm," Journalof AI and Data Mining, vol. 1, no. 2, pp. 85-96, 2014.

[6] O. Banimelhem, M. Mowafi, and W. Aljoby, "Genetic algorithm based node deployment in hybrid wireless sensor networks," Communications and Network, vol. 4, no. 5, pp. 273-279, November 2013.

[7] M. Sharawi, E. Emary, I. A. Saroit and H. El-Mahdy. (July 2014). Flower Pollination Optimization Algorithm for Wireless Sensor Network Lifetime Global Optimization. [Online]. 3(4). pp. 54-59. Available: https://www.researchgate.net/publication/270242178_Flower_Pollination_Optimization_Algorithm_for_Wireless_Sensor_Network_Lifetime_Global_Optimization

[8] F. Hajjej, R. Ejbali and M. Zaied, "An efficient deployment approach for improved coverage in wireless sensor networks based on flower pollination algorithm," in Proc. Computer Science & Information Technology (CS & IT), 2016.

[9] F. Hajjej, R. Ejbali, and M. Zaied, "Multi objective nodes placement approach in WSN based on nature inspired optimisation algorithms," in Proc. Second International Conference on Advances in Sensors Actuators, Metering and Sensing, 2017.

[10] S. Sarkar, H. Shanavas, and B. Vhavani, "Energy scavenging technology and components in WSN," Inter. Jour. Computer Network and Information Security, vol. 6, no. 3, pp. 44-51, 2014.

[11] F. Hajjej, R. Ejbali, and M. Zaied, "Sensor node deployment approach in wireless sensor network based on multi-objective flower pollination algorithm," Sensors & Transducers, vol. 213, no. 6, pp. 1-8, June 2017.

[12] F. Hajjej, R. Ejbali, and M. Zaied, "Quality of services based routing using evolutionnary algorithm for wireless sensor network," in Proc. 15th International Conferenence on Intelligent Systems Design and Applications, 2015.

[13] N. E. Mbarki, R. Ejbali and M. Zaied, "Recognition of human activities in smarthomes using stacked autoencoders," in Proc. Tenth International Conference on Advances in Computer-Human Interactions, 2017.