

Conservatory of Lifespan of Heterogeneous Wireless Sensor Network using ABC Algorithm

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Abstract

Wireless Sensor Network (WSNs) as the usage and development of wireless sensor network the problems related to wireless sensor network are apparent. The main issue considers here is the lifetime. When we consider about the homogeneous wireless sensor network several methodology available but in to maximize the lifetime of the wireless sensor network is progress in a slow space. The Artificial Bee Colony (ABC) algorithm which is swarm intelligence based technique is used to maximize the lifetime of the heterogeneous wireless sensor. This methodology is based on finding maximum number of disjoint connected covers that satisfy both sensing coverage and the network connectivity. The ABC technique involves three types of bees, employee bee. Onlookers and scout bee. The proposed method has been applied to variety of wireless sensor network. Based on the functions performed by these bees the energy consumption can be reduced and the lifetime of the heterogeneous WSNs is increased.

Keywords: Artificial Bee Colony (ABC), Connectivity, Coverage, Network Lifetime, Wireless Sensor Networks (WSNs)

1. Introduction

With the advance in Electronics and Communication Technology, the real time monitoring systems, such as battlefield surveillance¹, environment supervision², traffic control³ and the data collection of factors such as humidity, temperature, light and pressure, movement and direction of object in the interested area⁴. These type of application generally requires the use of the Wireless Sensor Networks (WSNs) and the quality of the service depend upon the network performance. The basic criteria for the Wireless Sensor Networks is the lifetime⁵ that satisfies the application requirements. Since most of the wireless device is powered by the non-renewable batteries, studying about the lifetime of the Wireless Sensor Network is the significant and the challenging issues in the Wireless Sensor Networks.

The existing method for the lifetime of the WSNs focus on the issues of the device placement⁶, data processing⁷, routing⁸, topology management⁹, and the device control^{10,11}. The device control approach involves the sleep

and wakeup approach¹². The device control approach focus on both monitoring and the communication tasks. The monitoring task involves the process of sensing coverage to the target and the communication task involves the process of collecting and disseminating the information via radio transmission. In a Wireless Sensor Network the device are densely deployed, so that the device in the sensing range is responsible for the transmission and other process while the other devices goes to the sleep state and it conserves the energy. However, the device should focus on both the network connectivity and the sensing coverage. Connected cover is one of the major factors that have to be considering for maximizing the lifetime of WSNs. The optimal connected cover is obtaining under certain constraints as minimum size¹³ and the minimum energy consumption¹⁴. However by using the above method, the optimal connected cover is not obtained. By maximizing the number of the connected covers is one of the more direct methods to maximize the lifetime of the Wireless Sensor Network. The problem of identifying the connected cover is difficult because it should satisfy both network

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connectivity and the transmission range. The lifetime can be maximized when the device have the transmission range twice than that of the sensing range while satisfying premises¹⁵ proposed greedy algorithm that satisfies both network connectivity and the sensing range.

The heterogeneous WSNs have the integral advantages in terms of reliability, robustness and energy efficiency¹⁶. The heterogeneous WSN is spectator in much number of applications. In order to persist the lifetime of the heterogeneous WSN, novel device placement¹⁷, routing protocol¹⁸, topology management strategies¹⁹, have been used. The considered heterogeneous WSN embrace of dualistic devices: sensors and the sinks. The sensors screen the aim and transmit the upshot to the sink. The sink conveys the scrutinised upshot to the terminus. Therefore the connected covers in the heterogeneous WSN must please the following constrictions: 1. The sensor form the wide-ranging attention to the target. 2. All the scrutinised upshot is then conveyed to the sink. 3. The sink unites the allied wireless network. These three constraints are inter-relating with every single other and the second constraint consists of both sensor and sink. By snowballing the number of connected covers, the lifetime of the heterogeneous WSNs can be enlarged, but it is problematic to upturn the connected covers. Heuristics ways and means are most auspicious method to give the high eminence solutions.

Artificial Bee Colony (ABC) is a well-known meta-heuristics inspired by the foraging behaviour of honey bee²⁰. The Artificial Bee colony algorithm consists of three group of bees, the employee bee that govern the food source from the prespecified set of food source and alter that information gained to others bees in the hive concluded through waggle dance. The onlooker bee, then search for the better source by the neighbourhood of the remembered food source through the info provided by the employee bee. Initially the Artificial Bee Colony algorithm was proposed for the continuous problem later it is modified for the discrete problem²¹. The energy consumption of ABC is compared with ACO. The ACO is a meta-heuristics method. The ACO uses pheromone as search experience and heuristics information for domain knowledge for the search process²².

2. Overview of Artificial Bee Colony Algorithm

ABC is the state-of-the-art algorithm based on the foraging behaviour of the insects. It mock-ups thee deeds of the honey bee. The honey bee use several mechanisms to

localise the food source and to exploration the new one. One of the mechanism is the waggle dance is the message between the bees. The bees share info about the distance, direction and also the nectar amount to find the finest solution to locate the food source. In ABC, the communal behaviour of bees simulated as a peak algorithm. Since ABC is laiddback to implement, very humble in concept and has few limits it is used in variety of applications.

The colony of artificial bees consists of three groups of bees to search food, which includes employee bee, onlooker bee and the scout bee. The first half of the colony consists of employee bee and the second half of the colony consists of onlooker bee. The employee bee first search for the food source and return to the hive and it informs the information related to the food source through the waggle dance. The onlookers waiting in the hive and it captures the information that is passed by the employee bee and the information shared is about nectar amount, direction and the distance. The employee bee whose food source is tired that time the scout bee finds the new solution and substitutes the employee bee.

Each employee bee is assigned to each food source. In ABC algorithm the position of the food source represents the possible solution to the optimization problem and the nectar amount of the solution represents the quality of the solution which defines the fitness of the solution.

fiti is the fitness value of the solution i which is proportional to the nectar amount of the food source in the ith position and N is the number of food source that is equal to the number of employee bee. In order to get the candidate food solution from the memory the ABC algorithm uses

$$vij = xij + xij (xij - xkj)$$

where $k=\{1,2,...N\}$, $K \neq i$, $j=\{1,2,...D\}$ is randomly chosen indexes is the random number between $[-1,1]$.

A. Replacement of Bee and Selection

In ABC, the position cannot be improved by the predetermined number of cycle in that case the food source is abandoned. Number of cycle is an important parameter for ABC algorithm is said as "limit" for abandonment. Assume the abandoned source is x_i and $j = \{1, 2, \dots, D\}$ the scout the replaces the abandoned food source by exploration space. Bees interact when they find the target nectar amount and the solution for the $j=x + r$ and $(0, 1)$ ($x_{max} - x_{min}$) problem is obtained by the strength of these bees interaction. ABC algorithm has been applied for the various optimization problems²³.

2.1 Particulars around the Algorithm

2.1.1 Initialization

The randomly distributed initial solution $x_i = (1, 2 \dots D)$ and is being dispread in the space.

2.1.2 Replica

The probability value for the food source is calculated by the following expression and the onlookers bee select the food source based on this probability,

$$P_i = \frac{fit_i}{\sum_{n=1}^N fit_n}$$

After calculating the food source for each candidate by artificial bee colony algorithm, its performance is compared with the old one that is stored in the memory. If the new value evaluated by ABC is equal or better than that of the old one then the old value is replaced by the new one or else the old value is retained.

2.1.3 Pseudo-code

1. Initialize the population of solution $x_i = \{1, 2 \dots D\}$.
2. Evaluate the population.
3. Iteration=1, repeat.
4. Produce new solution v_i for the employee bee using equation.
5. Apply the greedy selection process to the employee bee.
6. Calculate the probability p_i for x_i using the above equation.
7. Calculate new solution v_i for onlookers depending on the probability of x_i and evaluate them.
8. Apply greedy selection for the onlookers.
9. Check for abandoned solution, if exists then replace the old solution with the randomly produced new solution.
10. Check for best solution achieved so far.
11. Iteration=iteration+1.
12. Continue till terminating the condition.

3. Simulation Result

3.1 Artificial Bee Colony

In ABC algorithm initially the sensors are deployed and the transmission range and the id for each sensor

is defined and in runtime dynamically the number of executions, number of networks and the minimum and maximum number of sensors. Based on Artificial Bee Colony algorithm the selection for employee bee using greedy selection process and the probability is calculated and the fitness is obtained and then onlookers bees, fitness is compared with the old value and replace the old one by new value and if in case if the solution is abandoned the scout bee then play the role depending on the parameters. The number of execution is 1, number of networks 3, minimum number of sensor 5, maximum number of sensor 10. The lifetime probability for ABC algorithm is $4.9 \times 10^{26.0}$. The sensor deployment is given in Figure 1 and energy consumption in Figure 2.

3.2 Ant Colony Optimization

In ACO algorithm initially sensors are deployed and the transmission range, id for each sensor is defined in runtime; dynamically the number of execution, number of networks, minimum sensor and maximum sensor is defined. Based on ACO, pheromone and heuristic information the energy consumption is defined and in Figure 3 sensors deployment using ACO is defined and in Figure 4 defines energy consumption using ACO is showed. The number of execution is given as 1, number of networks as 3, number of minimum sensor is 5, maximum number of sensor as 10. The lifetime probability for Ant Colony Optimization involves the value of $1.0 \times 10^{10.0}$. While comparing ABC and ACO the rate of ABC is high and the ABC method gives less energy consumption and maximum lifetime when compared to ACO. In both ABC and ACO technique radio range, malicious server, client can be dynamically set.

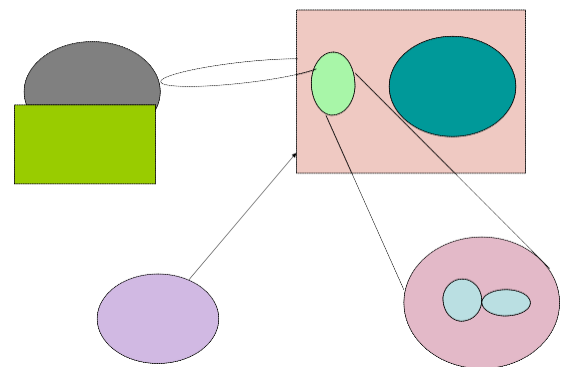


Figure 1. Architecture of ABC.

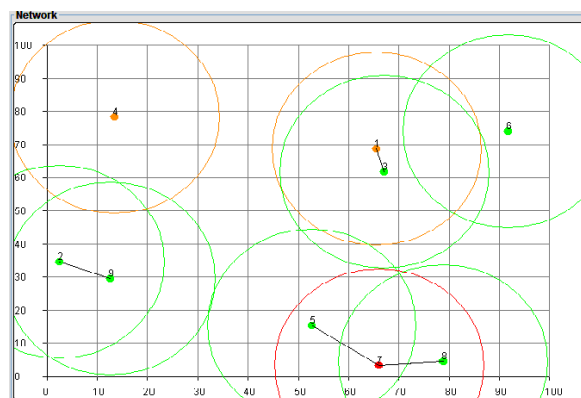


Figure 2. Sensor deployment, transmission range, id.

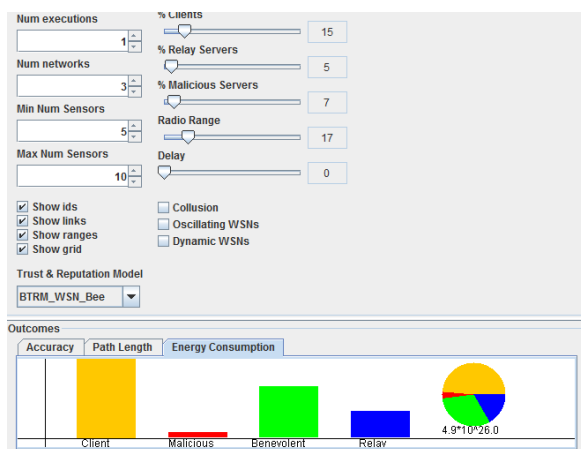


Figure 3. Energy consumption by ABC.

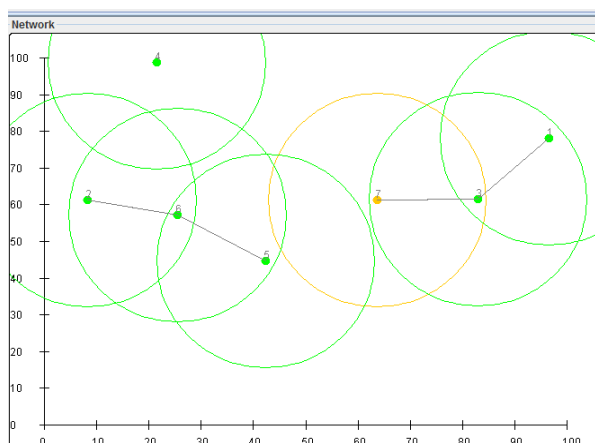


Figure 4. Sensor deployment, transmission range and id for each sensor.

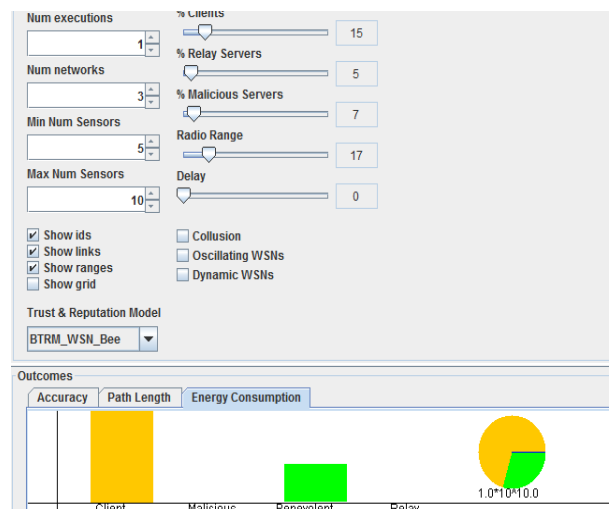


Figure 5. Energy consumption using ACO.

4. Conclusion

To maximize the lifetime of the heterogeneous wireless sensor network the swarm intelligence technique Artificial Bee Colony algorithm is used and it solves the connected cover problems that includes network connectivity and the transmission range. The ABC technique includes employee bee that search for the solution using the greedy selection process and followed by the onlooker bees and the scout bee is replaced in the case of abandoned employee bee and finally the lifetime of heterogeneous wireless sensor is increased by minimizing the energy consumption.

5. References

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