Lifetime Enhancement using Artificial Bee Colony Technique in Wireless Sensor Network

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Abstract— Recent leading in micro-manufacturing technology have approve the evolvement of low-cost, low-power, multifunctional sensor nodes for wireless communication. It counts the environmental monitoring, intrusion detection, battlefield surveillance, and so on. In a wireless sensor network (WSN), how to maintain the finite power resources of sensors to spread the network lifetime of the WSN as long as feasible while performing the sensing and sensed data reporting tasks, is the most condemning issue in the network design. In a WSN, sensor nodes distribute the sensed data back to the sink through multi-hopping. The sensor nodes near to the sink will almost always waste more battery power than others; consequently, these nodes will quickly lose their battery energy and minimize the network lifetime of the WSN. Sink relocation is a skilled network lifetime spreading out method, which minimize the wastage of too much battery energy for a specific group of sensor nodes. In this paper, we propose an Artificial bee colony (ABC) optimization technique to overcome from the drawbacks of Energy Aware sink re-localization technique (EASR), which is a moving strategy for mobile sinks in WSNs. The proposed mechanism used for solving the coverage problem and uses the information related to the residual battery energy of sensor nodes to adaptively adjust the transmission range of sensor nodes and the relocating scheme for the sink and main motive to locate sensors, global main positioning system (GPS) is also used by which sensor knows their position.

Key words: WSN, ABC, EASR

I. Introduction

A Wireless Sensor Network (WSN) is a autonomous device which uses the no. of sensor nodes to sense the data from environment condition. Generally, the sensed data guidelines are temperature, humidity, pressure, wind direction, sound intensity, pollution levels and vital body functions and this data is send through node by node to the main destination. The application of wireless sensor network is in medical field, battlefield surveillance, environment monitoring etc. These networks are used in process monitoring, many industrial and inventory monitoring. In wireless sensor network it is necessary to conserve the power of battery to increase the lifetime of the network.

A. *Architecture of WSN*

Wireless Sensor Network contains three main components: nodes, gateways, and software. The spatially distributed measurement node interface with sensors to monitor assets or their environment. The collected data wirelessly communicate to the gateway, which can perform independently or link to a host system where the grouping, development, analyse, and presentation of measured data using software. Routers are the special type of measurement node which is used to spread out the WSN distance and reliability. The WSN is built of nodes- from some to several hundred or can be thousands, where each node is connected to one (or sometimes several) sensors. Each such sensor network node has typically several parts:

1) A radio transceiver with an internal antenna or connection to an external antenna
2) A microcontroller
3) Sensors
4) An electric circuit for interfacing with the sensor sand an energy source (power source).
5) Usually a battery.

A sensor node might vary in size from that of a shoebox down to the size of a grain of dust, although functioning motes of genuine microscopic dimension have yet to be created. A sensor node also known as a mote which is a node in a sensor network that is capable of performing some processing, gathering sensory information and communicating with the other connected nodes in the network. A mote is a node but a node is not always a mote.

There are many techniques used in Wireless Sensor Network (WSN) to improve the Network life time. In the base paper, we use a moving strategy called energy-aware sink relocation (EASR) for mobile sinks in WSNs**.** The proposed mechanism uses information related to the residual battery energy of sensor nodes to adaptively adjust the transmission range of sensor nodes and the relocating scheme for the sink but the problem is coming in the network by this technique is battery drained out nodes causing the incurring coverage hole and communication hole problem. So to avoid this problem of EASR, we can use several soft computing technique such as: Genetic optimization(GA), Particle swam optimization(PSO), Artificial Bee Colony(ABC).

II. Implementation and Simulation

A. *EASR*

In this EASR technique, we integrate the method of energy-aware transmission range to adjust the transmission range of each sensor node according to its battery energy level. A node near to the sink consume more battery in comparison to other nodes and fastly drained out its battery quickly because all the transmission held in the network passes through this node and when the battery energy level of a node is getting low after some rounds of transmission, then the transmission range will be adjusted to be small for saving the energy of nodes. Then, the relocation of sink process is done by the EASR techniques, which re-locate the sink to the neighbor's nodes having high battery energy level. EASR use the MCP [11] routing protocol which is a dynamic routing protocol which provide the shortest path for transmission of data, which is very supportive technique for increasing the lifetime of wireless sensor network.

Although the EASR method can be incorporated with any existing routing method, we chose the Processes comes under the EASR method are:

1) Energy-Aware Transmission Range Adjusting

In general, by adjusting the high transmission range for a sensor node, increase the number of neighbor nodes and accordingly increase the quality of the energy-aware routing; however, it also bring the drawback of longer distance data relaying, which consume large amount of battery energy of a sensor node. On other hand, for a shorter range of transmission, it does not help too much for routing The adjustment of transmission range depends on the battery energy level of a sensor node. We can classify the nodes into three categories:- by the 'healthy' position of their battery and adjust the transmission range accordingly. Let u be the sensor nodes, B be the battery energy of node when the battery is full in the beginning, B/3 when the battery level is below the threshold and r (u) denotes the current battery energy level of a sensor node. In case, from limit $0 \leq r(u) < B/3$ (and $B/3 \leq r(u) < B/2$), the transmission range is shorter which can't help too much routing and we set its transmission range to $\gamma/4$ (and $\gamma/2$), respectively, where γ denotes the initial transmission range of a sensor node. For the case of $B/2 \leq r(u) \leq B$, the sensor node u is very healthy and better for the transmission and we set its transmission range to γ. Intuitively, a 'healthy' sensor node can adapt a larger transmission range to shorten the routing path, while a sensor node with only a little residual battery energy can tune the transmission range to be small to conserve its residual energy.

2) The sink relocation mechanism-

This mechanism consists of two parts. The first is to determine that where to trigger the sink or where to relocate the sink by evaluating current energy level of sensor nodes. The second part is to determine which direction the sink is heading in and the relocation distance as well. For the relocation condition, the sink will continuously find the residual battery energy of each sensor node in the WSN. After the finding process is completed, the sink will use the MCP routing protocol to compute the maximum capacity path w.r.t each sensor neighbor '*u*' of sink '*s*'.

B. Proposed Technique (Artificial Bee Colony Optimization)

It is a soft computing technique which provides a shortest path for the transmission and re-locates the sink to increase the network lifetime. Sensor nodes can be in trouble due to the various failures which may harm the operation of network. The failure of nodes can be happen by some reasons are: by deploying it in bad environment such as in volcanic area or battlefield location. And the failure in nodes causes damage of shortest path for transmission or due to which a sensor node fail to communicate. To overcome from this we use a DRFN method in ABC technique, which first detect the failed node in the network and then replace it by its neighbors node. So this method is applied to recover the failure in the communication or transmission process. For sending the data, colony consists of three groups:

- Employed bee: it checks the current battery energy level of sensor nodes and send the information of nodes energy to onlooker bee. This bee has its own path but side by side also search for new path by checking their battery level.
- Onlooker bee: It collects the info. Of sensors battery from employed bee and check the probability of better path.

$$prob_i = \frac{fiti}{\sum_{j=1}^{sn} fiti}$$

Where, $prob_i$ - refers to probability of X_i route to be selected,

sn - is the number of routes and is the fitness value of the route.

fit_i - fitness value of route X_i

C. Scout Bee

It provides the new path for transmission.

It is assumed that there is only one artificial employed bee for each battery level of sensor node. In other word, the no. of employed bee in the colony is equal to the number of sensor nodes around the network. The main steps of algorithm are given below:-

- Initial battery energy of nodes are produced for all employed bees
- REPEAT
- Each employed bee determines the new path by evaluating the battery level of nodes in the network.
- Each onlooker bee collect the data related to battery energy level of nodes by employed bee, and find probability for the best path. Abandoned food source are determined and are replaced with the new food source discovered by scout.
- The best food source found so far is registered.
- UNTIL(requirements are met)

D. Flowchart

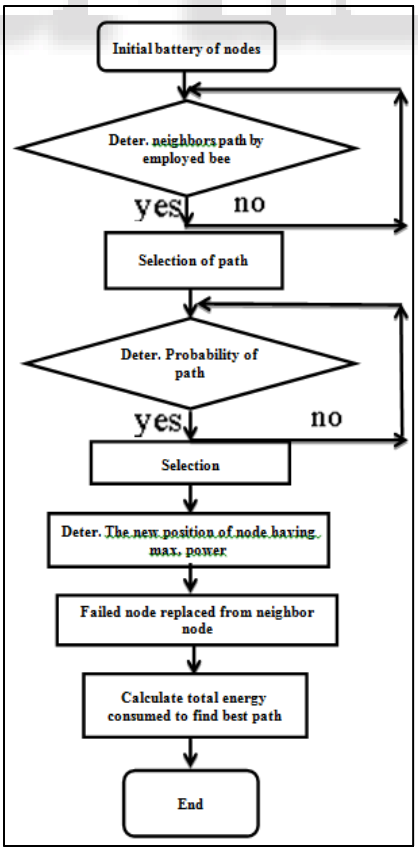


Fig. 1: Flowchart

III. RESULT AND DISCUSSION

A. *Lists of parameters setting for Simulation*

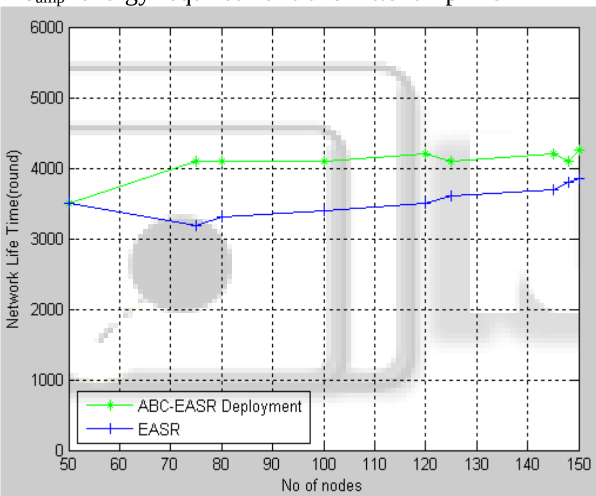
Simulation scenarios	Sim1	Sim2
Initial battery energy (J)	1000	500, 750, 1000, 1250, 1500
Transmission range (m)	25	
Simulation area (m^2)	100 · 100	
Number of nodes	50, 75, 100, 125, 150	100

Table 1: List of parameters settings for Simulation scenarios 1 and 2

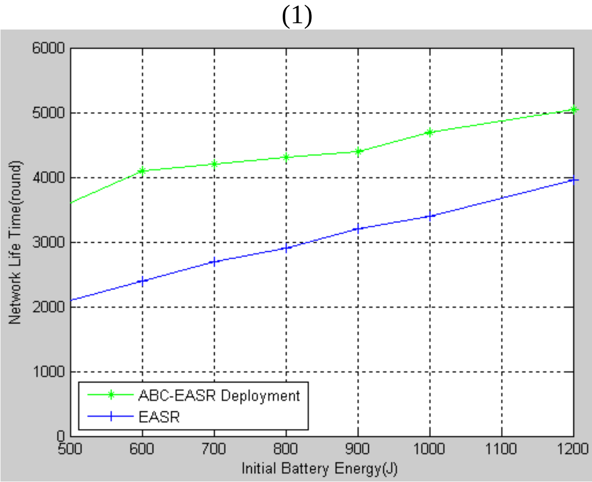
B. *Energy Consumption Model for Wireless Sensor Network*

$$E_{Tx}(k,d) = E_{elec} * k + €_{amp} * k * d^n$$
$$E_{Rx}(k) = E_{elec} * k$$

- $E_{Tx}(k,d)$- total energy required in sensor node to transmit k-bit length message to neighbor node at distance 'd'
- $E_{Rx}(k)$ – total energy required in sensor node to receive k-bit length message
- E_{elec} – energy consumed for driving the transmitter or receiver circuitry
- $€_{amp}$–energy required for transmitter amplifier



(1)



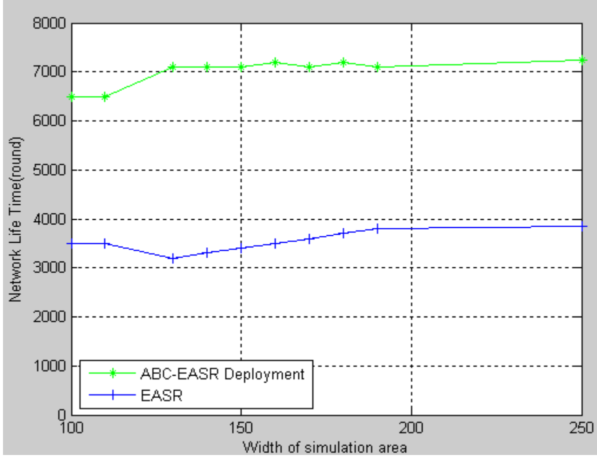
(2)

Fig. 2: Results 1, 2.

- Result(1): The n/w lifetime comparison varying no. of sensor nodes
- Result(2): The n/w lifetime comparison with varying initial battery energy

Simulation scenarios	Sim3	Sim4
Initial battery energy (J)	1000	
Transmission range (m)	25	20, 25, 30, 35
Simulation area (m^2)	100 · 100, 150 · 150, 200 · 200, 250 · 250	200 · 200
Number of nodes	100, 225, 400, 625	400

Table 2: List of parameters settings for Simulation scenarios 3 and 4



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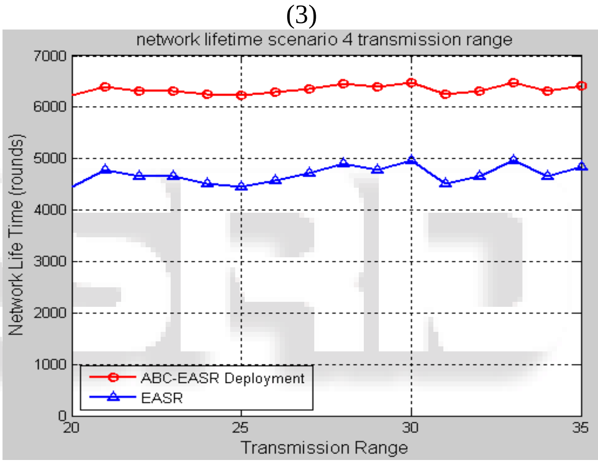

(4)

Fig. 3: Results 3, 4.

- Result (3): The n/w lifetime comparison with varying size of simulation area.
- Result (4): The n/w lifetime comparison varying transmission range

IV. CONCLUSION

- The failure of sensor node may occur in WSN due to lack of energy, low power batteries or harsh environment in which they are deployed.
- DRFN (detecting and replacing failed node) method in Artificial bee colony technique is used to overcome from this problem.
- This method reduce the energy consumption of sensor node and increase the network lifetime by reducing the communication hole problem.

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