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A Secure Data Aggregation Mechanism in Wireless Sensor Network

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Abstract:*The addition of mobility in WSN has attracted significant interest in recent years. Mobile nodes increase the capabilities of the WSN in many ways. We classify mobile wireless sensor networks (MWSNs) as a special and adaptable class of WSN, in which one or more than one element of the network is mobile. The mobile component can be any of the sensor nodes, relays (if any), data collectors or sink or any combination of them. From deployment to data dissemination, mobility plays an important role in every function of sensor networks. For example, a mobile node can visit other nodes in the network and gather data directly through single-hop transmissions. Similarly a mobile node can travel around the sensor network and collect data from sensors, buffer them, and then transfer them to base station. This considerably reduces only collisions and data losses, and also minimizes the pressure of data forwarding task by nodes and as a result spreads the energy consumption more consistently throughout the network.*

The proposed data aggregation mechanism uses bacterial foraging optimization algorithm. This technique is inspired by the social foraging behaviour like ant colony and particle swarm optimization. the proposed algorithm improves WSN throughput, collects data more efficiently, and saves energy.

Keywords: *mobile wireless sensor networks, data Aggregation.*

I. INTRODUCTION

In recent times, mobile WSNs (MWSNs) are growing as a new trend of WSN. A mobile wireless sensor network owes its name to the existence of mobile sink or sensor nodes within the network. Most of the basic characteristics of mobile wireless sensor network are identical to normal static WSN. In recent years Wireless Sensor Networks (WSNs) have become a usual technology for a large number of real world applications, ranging from monitoring (e.g., prevention of pollution, agriculture, volcanoes, structures and buildings health), to event discovery (e.g., intrusions, fire and flood emergencies) and target tracking (e.g., surveillance and monitoring). WSNs typically consist of large numbers of battery operated small devices whichdetermine and collect data from its nearby environment and forward it to a central base station or sink.

In recent years, there has been huge advancement in research and development of wireless sensor networks, which are now generally used in military, intelligent medical, and environmental monitoring fields [1]. Data collection is one of the key technologies applied in wireless sensor networks and as such has garnered particular attention from a large number of experts and scholars [2]. In traditional data collection program design, all nodes are fixed in position to collect data before being forwarded to the Sink through routing protocol [3]. Currently, the most challenging unsolved problems with this process include (1) the energy hole problem, where data streams follow a "many-for-one" mode which subjects nodes near the Sink to greater traffic load, resulting in early energy reduction and the creation of an "energy hole" around the Sink; (2) the communication overhead problem, where, because the self-energy of sensor nodes is restricted, there is control overhead regardless of the routing protocol algorithm and thus an intrinsic need to control the energy use of network nodes; and (3) the communication limit problem, where the data from some certain nodes cannot be transmitted and thus necessitates control strategies for communication reliability, when the network is not connected. Previous researchers have addressed the above problems by means of node mobility. The mobile node acts as a data collector, migrating through the network in accordance with distinct routes to conduct data collection in the monitoring region. By taking advantage of mobile node features, the connectivity, coverage, and energy distribution of mobile wireless sensor networks (MWSN) can be deployed dynamically or adjusted according to real-time conditions so as to fill in routing voids in the network and blind zones in the sensor. Existing MWSN can be roughly divided into three categories: (1) those in which the Sink node moves and the common node stands; (2) those in which the Sink node stands and the common node moves; and (3) those in which both the Sink node and common nodes move confirmed through broad analysis, this paper presents an efficient and reliable data collection method, a MWSN data collection program based on the bacterial foraging optimization algorithm.

II. Application Scenario Analysis and Related Works

Application Scenario Analysis. Mobile nodes can considerably reduce network energy expenditure and avoid the energy hole caused by multihop transmission so that data gathering is unaltered even if there is no data path between nodes. Mobiles nodes have mainly obvious advantages in sparse or unconnected networks [9]. however, because the speed of the moving node cannot be compared to the speed of wireless transmission, there is a delay from generation to transmission of sensor data.

In this study, we assumed the following characteristic application scenarios.

(1) all sensor nodes are movable.

(2) all node have sufficient of battery power, high storage capacity, and an suitable degree of mobility. same as that of an ordinary node.

(3) The intensive network allows some data transmission latency, and all nodes can be connected in a single- or multihop manner.

III. Related Works:

Many techniques have been used for data aggregation in wireless sensor network.

Saad Ahmed Munir, et al. [4] presented multi-tier architecture for the mobile wireless sensor network as a key element of future ubiquitous computing paradigm. they consider the multi-tier architecture in mobile WSN, with a special emphasis on integration into a pervasive network. The detailed architectural implementation is presented in this paper, followed by an analysis of the impact of mobility on performance related issues in WSN.

Swagatam Das, et al. [5] This chapter has provided a comprehensive overview of one promising real-parameter optimization algorithm called the Bacterial Foraging Optimization Algorithm (BFOA).

Xuhui Chen and Peiqiang Yu [6] has proposed architecture of wireless sensor network with mobile sensor nodes. The architecture is divided into high-end node layer and low-end node layer. The high-end nodes are responsible for the data routing, and the low-end nodes are responsible for sensing and reporting data so that the mobile sensor nodes can be freed from the complicated routing calculation and implementation, and improve the network performance effectively.

B.Pitchaimanickam and S.Radhakrishnan [7] In this paper, Bacteria Foraging Algorithm used to form the k-optimal clusters in the wireless sensor network and selected the efficient cluster head in the group of nodes

Ali Sayyed and Leandro Buss Becker [8] this chapter characterized different phases of Mobile Wireless Sensor Networks (MWSNs) operation. First they provided a general overview of MWSNs basics. They then defined and presented a review on different stages or aspects of MWSNs operation, that directly or indirectly affect the process of the data collection.

Yinggao Yue, et al. [9] have explored the use of mobile Sinks to collect data to solve the energy consumption bottleneck problem inherent to static networks by analyzing the relationship between mobile Sink data collection and energy consumption. By accounting for the selection of the cluster head node, the route from nodes to cluster heads, and shortest route of the mobile Sink, they built a heuristic artificial bee colony algorithm that can be applied to maximize data collection and minimize total energy consumption while optimizing network reliability.

IV. Problem Description

The key objective of this study was to develop a WSN with mobile nodes based on the bacterial foraging optimization algorithm which solves problems related to data acquisition quantity, energy consumption, network reliability, and a few other technical indicators.

V. Bacterial Foraging Optimization

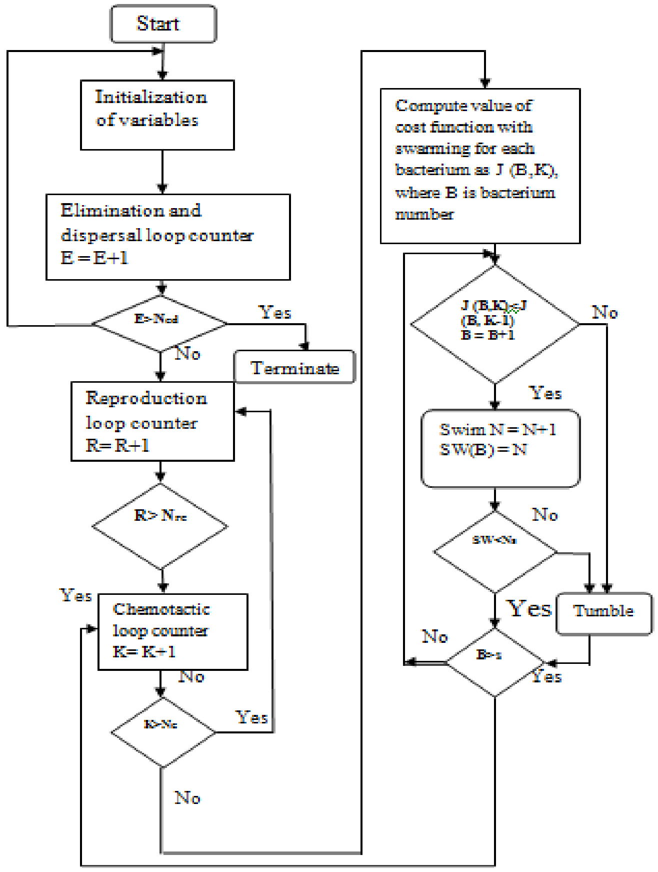
Bacteria Foraging Optimization Algorithm (BFOA), proposed by Passino [10], is a new comer to the family of nature-inspired optimization algorithms. For over the last five decades, optimization algorithms like Genetic Algorithms (GAs), Evolutionary Programming (EP), Evolutionary Strategies (ES) , which draw their inspiration from evolution and natural genetics, have been dominating the realm of optimization algorithms. Recently natural swarm inspired algorithms like Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO) have found their way into this domain and proved their effectiveness. Following the same trend of swarm-based algorithms, Passino proposed the BFOA in [10]. Application of group foraging strategy of a swarm of *E.coli* bacteria in multi-optimal function optimization is the key idea of the new algorithm. Bacteria search for nutrients in a manner to maximize energy obtained per unit time. Individual bacterium also communicates with others by sending signals. A bacterium takes foraging decisions after considering two previous factors. The process, in which a bacterium moves by taking small steps while searching for nutrients, is called chemotaxis and key idea of BFOA is mimicking chemotactic movement of virtual bacteria in the problem search space. Since its inception, BFOA has drawn the attention of researchers from diverse fields of knowledge especially due to its biological motivation and graceful structure. Researchers are trying to hybridize BFOA with different other algorithms in order to explore its local and global search properties separately. It has already been applied to many real world problems and proved its effectiveness over many variants of GA and PSO.
Below we briefly describe the four prime steps in BFOA.

(i)Chemotaxis: This process simulates the movement of an *.coli* cell through swimming and tumbling via flagella. Biologically an *E.coli* bacterium can move in two different ways. It can swim for a period of time in the same direction or it may tumble, and alternate between these two modes of operation for the entire lifetime.

ii) Swarming: An interesting group behavior has been observed for several motile species of bacteria including *E.coli* and *S. typhimurium*, where complex and stable spatio-temporal patterns (swarms) are formed in semisolid nutrient medium. A group of *E.coli* cells arrange themselves in a traveling ring by moving up the nutrient gradient when placed amidst a semisolid matrix with a single nutrient chemo-effecter. The cells when stimulated by a high level of *succinate*, release an attractant *aspertate*, which helps them to aggregate into groups and thus move as concentric patterns of swarms with high bacterial density.

(iii)Reproduction: The least healthy bacteria eventually die while each of the healthier bacteria (those yielding lower value of the objective function) asexually split into two bacteria, which are then placed in the same location. This keeps the swarm size constant.

iv) Elimination and Dispersal: Gradual or sudden changes in the local environment where a bacterium population lives may occur due to various reasons e.g. a significant local rise of temperature may kill a group of bacteria that are currently in a region with a high concentration of nutrient gradients. Events can take place in such a fashion that all the bacteria in a region are killed or a group is dispersed into a new location. To simulate this phenomenon in BFOA some bacteria are liquidated at random with a very small probability while the new replacements ar e randomly initialized over the search space.



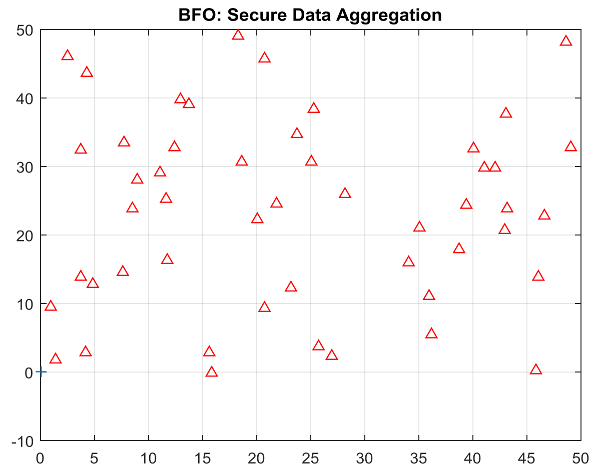
Steps of BFO Algorithm

VI. Experiment and Result

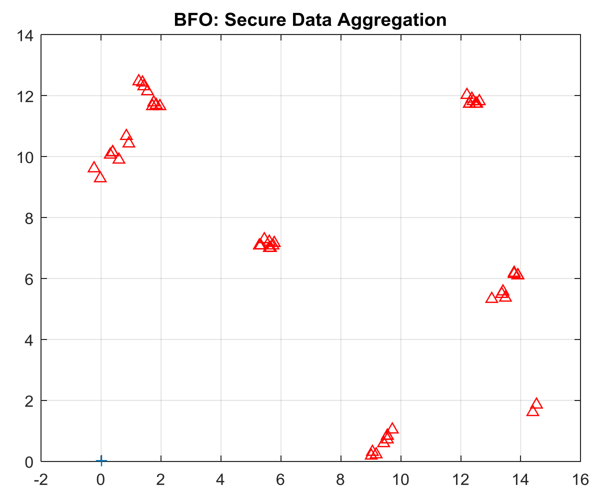
We used the MATLAB simulator to conduct performance analysis of the proposed method.In our simulation scenarios, 50 sensor nodes were deployed uniformly in a 50× 50m2 square area; other parameter settings are listed in Table.

Parameter	Value
No. of nodes	50
Simulation time	200
Coverage area	50m*50m
Initial energy in each node	5 Joules
MAC protocol	IEEE 802.11
Routing algorithm	None
Node Distribution	Uniform random
Transmission power of each node	12 Mw
Transmission range	15 m
Node capacity	5 buffers
Energy spent in transmission	0.75 W
Energy spent in reception	0.25 W
Energy spent in sensing	10 Mv
Sampling Period	0.5 s

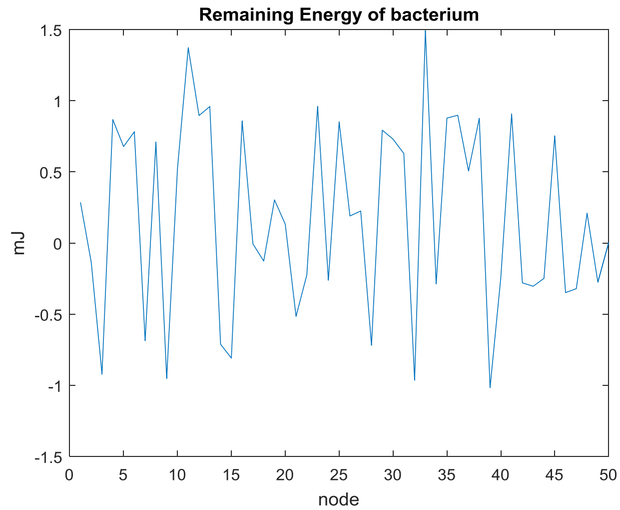
Node mobility	Mobile



The figure above shows the Simulation of 50 nodes in MATLAB.



Cluster head formulation during secure aggregation



Remaining energy of node after data aggregation

VII. Conclusion and Future Work

There have been considerable research activities to improve data collection in MWSN. But there has been always an issue concerning the mobility of nodes, energy consumption, low-cost device, estimation errors and accuracy of the proposed solutions. So there is a need of improvement in data collection technique.

The proposed data aggregation mechanism uses bacterial foraging optimization algorithm. This technique is inspired by the social foraging behavior like ant colony and particle swarm optimization. It attracts the researchers due to its effectiveness in solving real world optimization problems and gives better results than conventional methods of problems solving. Simulation results show that, compared to similar existing algorithms, the proposed algorithm improves WSN throughput, gather data more efficiently, and saves energy. This research work was done on network with mobile sensor. In this research work only sensor nodes are mobile. in future, work can be done on network with mobile sink and we can also do data aggregation in the presence of malicious nodes.

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