PHEROMONE-ORIENTED TRANSMISSION FOR LOAD-BALANCED DATA GATHERING IN WIRELESS SENSOR NETWORKS

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Abstract. *In large-scale wireless sensor networks, hundreds or thousands of micro-sensor nodes with such resource limitations as battery capacity, memory, CPU, and communication capacity are deployed in an observation area and used to monitor and gather information of environments. Therefore, a scalable, efficient, and load-balanced data gathering method is needed to prolong the lifetime of wireless sensor networks. This study proposes a novel method for the long-term operation of wireless sensor networks, named the pheromone-oriented transmission method. In the pheromone-oriented transmission method, the load of each sensor node is autonomously balanced. We evaluate the proposed method by computer simulations and discuss its development potential. In simulation experiments, the performance of the proposed method is investigated in detail to verify its effectiveness.*
Keywords: Large scale wireless sensor networks, Multiple sinks, Load balancing, Ant-based routing algorithms

1. Introduction

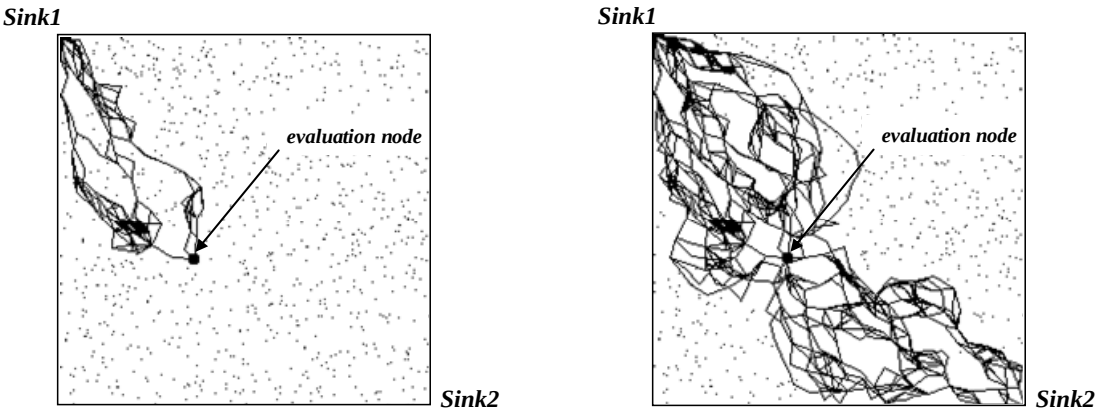
There is growing expectation for wireless sensor networks as a means of realizing many applications, such as natural environmental monitoring, environmental control in office buildings and factories, object tracking, and precision agriculture. In large-scale wireless sensor networks, hundreds or thousands of micro-sensor nodes with such resource limitations as battery capacity, memory, CPU, and communication capacity are deployed in an observation area and used to monitor and gather information of environments. Therefore, a scalable, efficient, and load-balanced data gathering method is needed to prolong the lifetime of wireless sensor networks. The ant-based routing algorithms[1] have attracted attention as algorithms for saving energy consumption because they are more scalable and efficient than other conventional routing algorithms. In previous studies, we proposed an Advanced Ant-based Routing (AAR) algorithm[2], which is more scalable and efficient than conventional ant-based routing algorithms. This study proposes an AAR-inspired novel method for the long-term operation of wireless sensor networks, named the Pheromone-Oriented Transmission (POT) method. In the POT method, the load of each sensor node is autonomously balanced. We evaluate the proposed POT method by computer simulations and discuss its development potential. In simulation experiments, the performance of the proposed POT method is investigated in detail to verify its effectiveness.

2. Pheromone-Oriented Transmission and Experimental Results

The POT method is a novel method that adaptively reduces the load on load-concentrated nodes and facilitates the long-term operation of wireless sensor networks. The routing table of each node is composed of the pheromone value of every neighbor node. In the POT method, each node determines a relay node of sensing data based on the pheromone value updated by considering the residual energy of neighbor nodes. Consequently, the destination (sink) node and the route to the sink node are determined. The conditions of simulation, which were used in the experiments performed, are shown in Table 1. The routes used by applying the POT method are shown in Fig.1. Of the 2,000 sensing data transmissions from the evaluation node, the routes in (1) were used 1 to 300 times and those in (2) 1 to 2,000 times. The load-balanced data transmissions are achieved. In Fig.2, the transition of the delivery ratio from a total of 20 nodes randomly selected to sink nodes is shown and the lifetime of wireless sensor networks is compared, where the Minimum Route Transmission (MRT) method in the figure is general data transmission method by the shortest route and the Modified Uniform Ant Algorithm (MUAA) is a promising ant-based routing algorithm[1]. From the results, it can be confirmed that the POT method is effective for the long-term operation of wireless sensor networks.

Table1 Conditions of simulation

Simulation size	*2,400 m × 2,400 m*
The number of sensor nodes	*1,000*
Range of radio wave	*150 m*
The number of sink nodes	*2*



(a) 1 to 300 times (b) 1 to 2,000 times

Fig.1 Routes used by applying the POT method

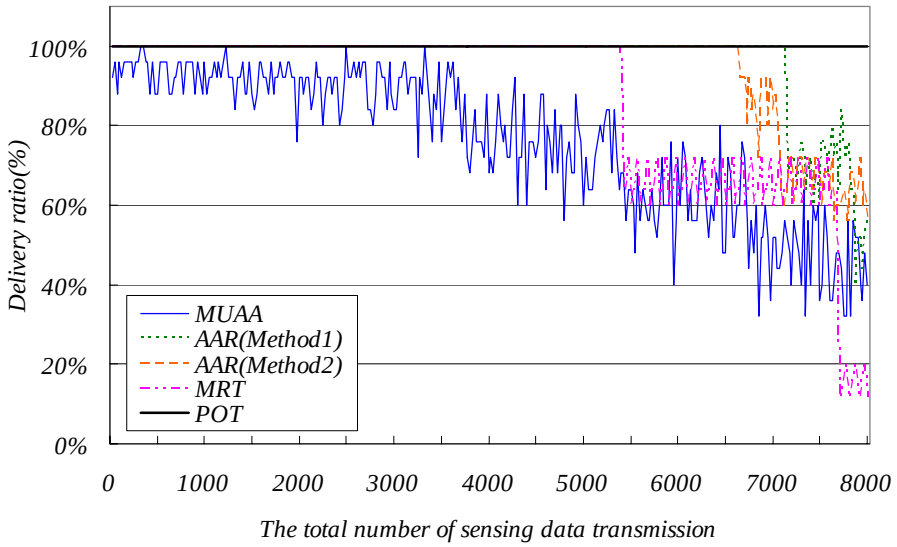


Fig.2 Transition of delivery ratio

3. Conclusions

In this paper, a novel method that adaptively reduces the load on load-concentrated nodes and facilitates the long-term operation of wireless sensor networks, named the Pheromone-Oriented Transmission (POT) method, has been proposed. Through experimental results, it has been confirmed that the proposed POT method has the development potential as a promising method for the long-term operation of wireless sensor networks.

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