Performance of Termite-Hill Routing Algorithm on Sink Mobility in Wireless Sensor Networks

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Abstract. High efficient and energy-aware routing is an important issue for the design of resource constrained environments like Wireless Sensor Networks (WSNs). Many protocols have been developed for WSN that try to overcome the constraints that characterized this type of networks. Termite based routing protocols can add a significant contribution to assist in the maximization of the network lifetime without performance degradation. But this is only possible by means of an adaptable and balanced algorithm that takes into account the main constraints of WSN. This paper presents a biological inspired self-organized routing protocol for WSN which is based on termite colony optimization metaheuristic termed Termite-hill. The main objective of the proposed algorithm is to efficiently relay all the traffic destined for the sink, and also balance the network energy. The results of our extensive experiments on Routing Modeling Application Simulation Environment (RMASE) demonstrated that with sink mobility, our proposed routing algorithm was able to balance the network traffic load and prolong the network lifetime without performance degradation.

Keywords: Swarm Intelligence, Wireless Sensor Networks, Energy Efficiency, Termite-hill, Network Lifetime, Network Throughput, Routing Algorithm.

1 Introduction

Wireless Sensor Networks (WSNs) are collections of compact-size, relatively inexpensive computational nodes that measure local environmental conditions, or other parameters and forward such information to a central point for appropriate processing. Many applications of sensor networks deals with the static nature of nodes which in most cases sense their environment and then send the measured values to a central base station through hop-to-hop (multi-hop) routing, hence leading to rapid exhaustion of energy around the sink (base station). The issue is that, sensor nodes

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around the sink tend to deplete faster in energy than those farther away. This is mainly because, besides forwarding their own traffic, they forward traffic on behalf of other sensors nodes that are located farther away from the sink node. Hence, the lifetime of sensor network can be improved upon if the energy spent in traffic relaying to the sink is reduced.

Social insect communities have many desirable properties from the WSN perspective as surveyed in [1, 2]. These communities are formed from simple, autonomous, and cooperative organisms that are interdependent for their survival. Such systems may be composed of simple nodes working together to deliver messages, while resilient against changes in its environment. The environment of sensor network might include anything from its own topology to physical layer effects on the communications links, to traffic patterns across the network. A noted difference between biological and engineered networks is that the former have an evolutionary incentive to cooperate, while engineered networks may require alternative solutions to force nodes to cooperate. Research on the field of swarm intelligence has been focused on working principles of ant colonies as adopted in [3], and honey bees [4]. To the best of our knowledge, little attention has been paid in utilizing the organization and behavioral principles of other swarms such as termites to solve real world problems. The study of termite behavior has revealed remarkable achievements in the communication capabilities as compared to ants and honey bees as adopted in [5]. To this end, we proposed an on-demand and probabilistic routing algorithm termed Termite-hill. In this algorithm, termite agents were modeled to suit the energy resource constraints in WSNs for the purpose of improving the network lifetime, by extensively borrowing from the principles behind the termite communication.

The rest of the paper is organized as follows. Section 2 gives an overview of related work. In Section 3 we describe our proposed algorithm. Section 4 discusses the experimental environment and results. Section 5 concludes the paper with comments for future work.

2 Related Work

The idea of using the swarm paradigm to establish routes in communication networks is not new. In [3], an ant-based algorithm was adopted to calculate the optimal paths among the nodes through an architecture called AntNet. Small agents, the virtual ants, migrate from a node to another, building the routing rules in a distributed way.

In Sensor driven and Cost-aware ant routing (SC) [6], it is assumed that ants have sensors so that they can smell where there is food at the beginning of the routing process so as to increase in sensing the best direction that the ant will go initially. In addition to the sensing ability, each node stores the probability distribution and the estimates of the cost of destination from each of its neighbors. Though, the protocol suffers from misleading when there is an obstacle which might cause errors in sensing. In their extended work, Flooded Forward ant routing (FF) [6] argues the fact that ants even augmented with sensors, can be misguided due to the obstacles or moving destinations. The protocol is based on flooding of ants from source node to the sink node. In the case where destination is not known at the beginning by the ants,