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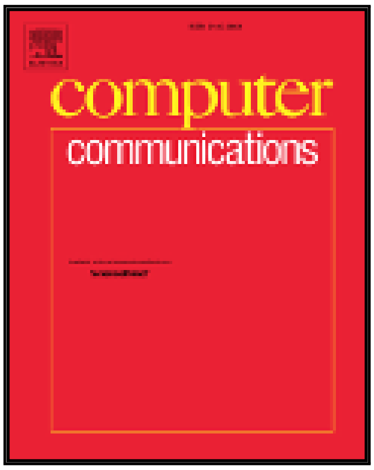

LA-CWSN: A Learning Automata-based Cognitive Wireless Sensor Networks

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LA-CWSN: A Learning Automata-based Cognitive Wireless Sensor Networks

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Abstract-Cognitive networking deals with using cognition to the entire network protocol stack to achieve stack-wide, as well as network-wide performance goals; unlike cognitive radios that apply cognition only at the physical layer to overcome the problem of spectrum scarcity. Adding cognition to the existing Wireless Sensor Networks (WSNs) with a cognitive networking approach brings about many benefits. To the best of our knowledge, almost all the existing researches on the Cognitive Wireless Sensor Networks (CWSNs) have focused on spectrum allocation and interference reduction, which are related to the physical layer optimization. In this paper, an inference and learning model for CWSNs, named LA-CWSN, is proposed. This model uses learning automata to bring cognition to the entire network protocol stack, with the aim of providing end-to-end goal. Learning automata are assigned to the parameters of the important network protocols. Each automaton has a finite set of possible values of the corresponding parameter, and it tries to learn the best one, which maximize the network performance. Each node in the network has its own group of learning automata, which act independently, however all nodes receive the same feedbacks from the environment. To clarify the proposed model a traffic control scenario in WSN is considered. Using the network simulator ns-2.35, we test the proposed inference and learning model for traffic control in a WSN. The results show that learning automata approach works well to apply cognition in WSNs.

Keywords - Cognitive; Learning Automata; Traffic Control; Wireless Sensor Network

1. Introduction

Wireless Sensor Networks (WSNs), which consist of small and inexpensive communication nodes, are the results of recent advances in processing capability, memory capacity, and radio technology [1]. These networks can sense their environments and communicating with each other. They are also developed at a cost much lower than traditional wired sensor systems. However, the design of WSNs is facing many challenges; some of them are as follows. Since the power source of the sensor nodes is limited and un-chargeable, energy efficiency and life time maximization are two key design factors. Spectrum allocation is another important problem in WSNs, because of the limited bandwidth and the spectrum scarcity, which cause interference in WSNs. Another challenge, which causes an end-to-end delay, is the sensing duration time. Collision occurs in WSNs because of the hidden terminal problem, whereupon control and data packets may be lost; so, managing access to the common medium is another important feature in designing WSNs.

To overcome some of the above designing challenges in a WSN, a cognitive technology has been proposed in [2-7]; the proposed solution, which has used cognitive radio, has been a new approach to the spectrum allocation and utilization concept. Generally, a cognitive radio [8] applies cognition only at the physical layer to dynamically detect and use spectrum holes, focusing strictly on dynamic spectrum access; whereas, the objective of cognitive networking [9-12] is to apply cognition to the entire network protocol stack for reaching network-wide performance goals.

Cross-layer design is another approach, which has used to overpower the designing challenges in WSNs. The cross-layer design refers to an explicit violation of the reference layer architecture [10], and it usually focuses on merging and/or splitting of layers, to achieve a particular goal. Every cross-