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Algorithms, Protocols and Future Applications of Wireless Sensor Networks

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The fast growth of embedded micro-sensing MEMS and wireless communication technologies has greatly accelerated the development of *wireless sensor networks* (*WSNs*). WSNs can offer lots of opportunities for pervasive and context-aware applications that have close interactions with our physical environments. However, due to limited resources of sensor nodes, WSNs may face many critical challenges. For example, algorithms for network formation, data collection, sensor data compression, data-centric routing, energy-driven transmission, light-weight security and authentication, and fault-tolerant computing and communications that are tailored to the needs of WSNs must be developed. Standardization of these designs is necessary to facilitate the designs of WSN protocols for global compatibility. Also, these issues must keep the applications and performance in mind since WSNs are application-driven systems.

This special issue aims at reporting recent researches and progresses in the development of WSNs. We have received totally 39 submissions. Each paper has been carefully reviewed by at least three reviewers. Among them, nine outstanding articles have been accepted, giving an acceptance rate of 23%. These articles can be classified into four categories: 'network formation', 'data compression and energy conservation' and 'applications'.

In the category of 'network formation', the paper entitled 'The Critical Grid Size and Transmission Radius for Local-Minimum-Free Grid Routing in Wireless Ad Hoc and Sensor Networks' derives some critical parameters and formulates sufficient and necessary conditions for local-minimum-free grid routing in wireless ad hoc and sensor networks. In the paper entitled 'Graph Matching-Based Distributed Clustering and Backbone Formation Algorithms for Sensor Networks', a new weighted matching method based on graph theory is proposed for node clustering in a WSN. It is claimed to be the first result using graph matching for selecting strong communication links while creating a controllable number of balanced clusters in the literature. Observing that WLANs have wider coverage and higher bandwidth, the paper entitled 'Saving Energy in Wireless Local Area Sensor Networks' proposes using IEEE 802.11 WLANs to develop local-area WSNs. This paper discusses the energy consumption of such networks analytically, gives the considerations that should be taken care of and proposes a novel group collaboration protocol for energy conservation in WLANs.

In the category of 'data compression and energy conservation', the paper entitled 'Adaptive Linear Filtering Compression on Realtime Sensor Networks' presents a lightweight WSN compression scheme for seismic data. The scheme eliminates the need to determine prediction coefficients *a priori* and allows the compressor to dynamically adjust to a changing source. Interestingly, the result has been tested in a real WSN deployed on St. Heleus Volcano. Concerning the trade-off between network utility and network lifetime, the paper entitled 'Cross Layer Optimization for Energy-Constrained Wireless Sensor Networks: Joint Rate Control and Routing' introduces a weighted factor that combines these two objectives to address both rate control and routing issues in a WSN. The result can deal with reliable and real-time communications and contain rigorous analyses. The paper entitled 'Efficient Query-Based Data Collection for Mobile Wireless Monitoring Applications' addresses an interesting problem, where a mobile sink may issue a query packet at one location, move to another location

and then collect the response packet at the new location. Two efficient protocols are proposed to minimize energy consumption and packet delivery latency for sensor data collection in such a mobile environment.

In the category of 'applications', three papers are selected: one addressing localization, one addressing rapid implementation of WSN applications and one addressing code injection. The paper entitled 'Localization Algorithms for Wireless Sensor Retrieval' adopts probability models to develop two efficient localization algorithms by iteratively identifying the locations of multiple sensor nodes. The paper entitled 'Moppet: A Model-Driven Performance Engineering Framework for Wireless Sensor Networks' proposes a framework for application developers, or even non-programmers, to rapidly implement WSN applications, estimate their performance and feedback the estimated performance results for customizing their design/implementation. For example, network lifetime and power consumption can be inferred. The paper entitled 'Arbitrary Code Injection through Self-propagating Worms in Von Neumann Architecture Devices' points out that lightweight sensor nodes present a new and very disturbing target for malware developers. It shows how to intrude a remote node over the radio channel, presents an implementation of the attack and suggests possible countermeasures.

These papers represent exciting and insightful observations into the state of the art, as well as emerging future trends, of the development of WSNs. We hope that these articles can also help stimulate future research and development of WSNs.

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