Editorial

Hybrid Wireless Sensor Networks: Theory and Design

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Hybrid wireless sensor networks consist of wireless networks (such as cellular network) and wireless sensor networks. Such network is important to overcome the limitations of conventional sensor network where transmission range and data rate are quite limited. The focus of this special issue is on the hybrid wireless sensor network formed by wireless sensor nodes and base stations (cellular networks). Wireless sensor network without support from the fixed infrastructure is known as ad hoc sensor networks. Due to the lack of infrastructure, the data is forwarded to the destination via a multihop fashion. In other scenarios, a set of base stations are connected by wired links and placed within the ad hoc sensor networks to form a wired infrastructure, aiming to enhance the whole network performance. This resulting network is referred to as a hybrid wireless sensor networks. A typical application scenario includes large area monitoring where traditional wireless sensor network is too limited, for example, highway traffic surveillance and real-time online inquiry across Texas.

This special issue contains 20 papers selected from submissions to the open call for papers in this special issue. These papers highlight some of the current research interests and achievements in the area of hybrid wireless sensor networks.

A core factor to consider when designing wireless sensor networks (WSN) is the reliable and efficient transmission of massive data from source to destination. The paper by Y. Zhao et al. proposes a neighborhood-based nonnegative matrix factorization model to predict link quality in wireless sensor networks.

The paper by S. Liu and Z. Zhang focuses on the issue of cloud detection in wireless sensor networks and proposes a novel detection algorithm named adaptive graph cut (AGC) to tackle this issue.

The paper by Z. Sun et al. proposes a new cyclic feature recovery approach based on the reconstruction of autocorrelation sequence from sub-Nyquist samples, which can reduce the computation complexity and memory consumption significantly, while the recovery performance remains well in the same compressive ratio.

The paper by Y. Hu and J. Liang proposes two constant-false-alarm rate (CFAR) decision fusion approaches, the low-SNR and likelihood-ratio-based decision fusion in the central limit theory (LLDFCLT), and high-SNR and likelihood-ratio-based decision fusion in Kaplan-Meier estimator (HLDFKE). They are based on the clustered radar sensor network model which combines clustering structure, target detection model, and fusion scheme.

The paper by S. Liu and Z. Zhang focuses on the issue of ground-based cloud classification in wireless sensor networks and proposes a novel feature learning algorithm named discriminative salient local binary pattern (DSLBP) to tackle this issue.

The paper by J. Yu et al. proposes a novel fractional filter design and cross-term elimination in Wigner distribution.

In hybrid sensor networks, information fusion from heterogeneous sensors is important, but quite often information such as image is blurred. The paper by M. Shi and S. Liu proposes an efficient point spread function (PSF) estimation algorithm based on gradient cepstrum analysis.

The estimation accuracy of direction-of-departure (DOD) and direction-of-arrival (DOA) is reduced because of Doppler shifts caused by the high-speed moving sources.

The paper by F. Zhao et al. proposes an improved DOA estimation method which combines the forward-backward spatial smoothing (FBSS) technique with the MUSIC algorithm for virtual MIMO array signals in high-mobility scenarios.

Human action recognition in wireless sensor networks is an attractive direction due to its wide applications. However, human actions captured from different sensor nodes in WSN appear in different views, and the performance of the classifier tends to degrade sharply. The paper by Z. Zhang and S. Liu focuses on the issue of cross-view action recognition in WSN and proposes a novel algorithm named discriminative transferable sparse coding (DTSC) to overcome the drawback.

Recognizing human action in wireless sensor networks has raised a great interest owing to the requirements of real-world applications. Recently, the bag-of-features (BOF) model has proved effective in human action recognition. The paper by Z. Zhang and S. Liu proposes a novel method named local random sparse coding (LRSC) for human action recognition in WSN based on the BOF model.

The paper by F. Zhao and X. Sun proposes a method of Doppler frequency spread (DFS) estimation algorithm which is suitable for high-mobility Orthogonal Frequency Division Multiplexing (OFDM) systems. DFS is a main factor which may mitigate the performance of system. The proposed method is based on autocorrelation function algorithm of received signal which utilizes cyclic prefix (CP) to estimate Doppler spread.

The hull stress monitoring system is to measure and display the ship motions and real-time stresses by strain gauge and accelerometer sensor networks. The statistical parameters such as standard deviation of measurements through hull stress sensor network are important for the analysis of hull structure status. The paper by W. Wang and S. Qin presents an algorithm for standard deviation computed of hull stress data based on nested array.

With the explosive increase of mobile data traffic, the energy efficiency issue in cellular networks is a growing concern. The paper by C. Fang et al. analyzes the energy-delay tradeoff problem in the context of single base (BS) station, which has a cache capacity to buffer the contents through it.

Hybrid wireless sensor network made up of wireless body area networks (WBANs) and cellular network provides support for telemedicine. It has been proved that the successful recovery rate of Multiple Measurement Vectors (MMV) model is higher than the Single Measurement Vector (SMV) case. The paper by W. Li et al. proposes a simple algorithm of transforming the SMV model into MMV model based on the correlation of electrocardiogram (ECG), such that the MMV model can be used for general ECG signals rather than only several special signals.

The paper by H. Yao et al. proposes a multicontroller load balancing approach called hybrid flow in software defined wireless networks, which adopts the method of distribution and centralization and designs a double thresholds approach to evenly allocate the load.

The paper by F. Gong et al. addresses the problem of DOA estimation in positioning of nodes in wireless sensor networks. The Stochastic Maximum Likelihood (SML) algorithm is adopted in this paper.

Cooperative spectrum sensing (CSS) is a very important technique in cognitive wireless sensor networks, but the channel and multipath affect the sensing performance. For improving the sensing performance, the paper by S. Wang et al. incorporates a modified double-threshold energy detection (MDTED) and the location and channel information to improve the clustering cooperative spectrum sensing (CCSS) algorithm.

The paper by W. Zou et al. proposes an interference avoidance mechanism for Chinese Wireless Body Area Network (WBAN). This mechanism firstly classifies the channels by priority based on the distribution characteristics of potential interference on the China medical band, commits energy detection on all channels in the network initialization phase, and compares to energy threshold to form available channel set. Then differentiated channel maintenance strategy is utilized to avoid interference as far as possible in network running phase.
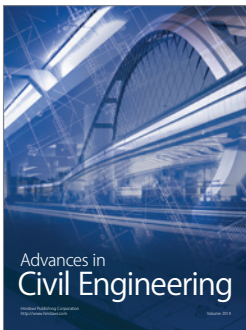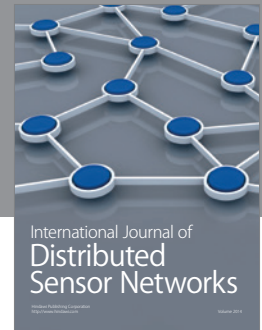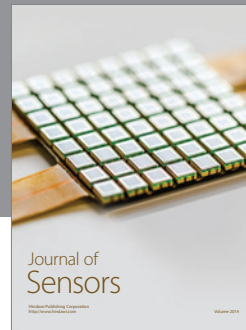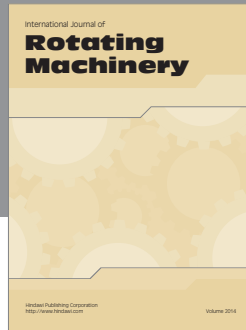
With the recent progress of Machine-to-Machine (M2M) communication technology, especially the enormous M2M devices and unique service of M2M, some challenges are emerging to the traditional wireless access and core networks, especially the congestion problem due to simultaneously bursty M2M service. Following this paradigm, the purpose of the paper by F. Xu et al. is to support and optimize the signaling aggregation and barring of M2M services based on cellular network.

The distributed target detection system with multiple Terahertz sensors is presented in the paper by Y. Yu et al. The distribution of THz radar system noise is measured and investigated to confirm the applicability of the detection algorithm in THz band. Experiments with multiple THz sensors are performed to detect single and multiple point-like targets, respectively.

Acknowledgments

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