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MONET Special Issue on Towards Future Ad Hoc Networks: Technologies and Applications (I)

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An ad hoc network is a wireless system in which network nodes are connected via wireless links and cooperate to self-organize into a network with no need for any infrastructure such as access points or base stations. Ad hoc networks cover a variety of paradigms such as mobile ad hoc networks (MANETs), wireless sensor networks (WSNs), vehicular ad hoc networks (VANETs), underwater networks, airborne networks, underground networks, personal area networks, and home networks. These types of networks promise a wide range of applications in civilian, commercial, and military areas. However, the distributed and multi-hop nature of ad hoc networking as well as the highly dynamic topology of ad hoc networks due to node mobility have presented many formidable technical challenges, such as scalability, quality of service, reliability and security, and energy efficiency, which have stimulated a considerable amount of research activities in this broad area in recent years.

This special issue includes six papers that report recent research advances in the area of ad hoc networks, among which four papers are selected from AdHocNets 2018 and two are selected from open call. In the first paper, "Prediction Based Vehicular Caching: Where and What to Cache", Zhang et al. proposed a prediction based vehicular caching scheme by exploiting the performance of a vehicular caching scheme where the role of moving vehicles changes from service consumers in traditional networks to service providers and service consumers. Specifically, an optimization problem is firstly formulated by exploring the relationship of caching vehicles and mobile users to optimize the network energy efficiency. The nonconvex optimization problem is solved by decomposing it into a nonlinear programming problem. By applying the Lyapunov method and autoregressive neural network (ANN), an online caching decision algorithm is further proposed to make caching decisions. Simulations Results show that the vehicular caching scheme can obviously improve network energy efficiency with different requests. The comparison between online and offline caching also shows the necessity of online caching decision making due to its benefit in resource utilization where the system gain increases from 8.4% to 59.24%.

In the second paper, "Task Allocation in Semi-Opportunistic Mobile Crowdsensing: Paradigm and Algorithms," Gong et al. proposed a new mobile crowdsensing paradigm, named semi-opportunistic sensing, aiming to achieve both high task coverage and low worker employment fee. In this paradigm, each worker can provide multiple candidate moving paths for his/her trip, among which the service platform chooses one for the worker to undertake task(s). The platform selects workers and assigns tasks to them with an objective to optimize total task quality under the platform's incentive budget and workers' task performing time constraints. The authors formulated the task allocation problem, proved its NP-hardness, and presented two efficient heuristic algorithms. The first heuristic, named Best Path/Task first algorithm (BPT), always chooses the best path and task in a greedy manner. The second heuristic, named LP-Relaxation based algorithm (LPR), assigns paths and tasks with the largest values according to the LP-relaxation. Experiment results show that the proposed semi-opportunistic sensing paradigm can significantly improve total task quality compared with opportunistic sensing.

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In the third paper, "Connectivity Based *k*-Coverage Hole Detection in Wireless Sensor Networks," Yan et al. proposed a connectivity based k-coverage hole detection algorithm and adopted Rips complex in homology theory to model a wireless sensor network (WSN). A simplicial complex reduction algorithm is first proposed to simplify the network topology by vertex and edge deletion, while keeping the homology intact. Then a connectivity-based algorithm is proposed for discovering the boundary cycles of non-triangular k-coverage holes. The proposed algorithm consists of two stages, one is for 1-coverage hole-detection and the other is for coverage degree reduction. In the 1-coverage hole-detection stage, boundary cycles of 1-coverage holes are found. In the coverage degree reduction stage, an independent covering subset of nodes in the covered region is found and the nodes are set to a dormant state to decrease the coverage degree of the target region by one. Simulation results show that more than 95% of non-triangular k-coverage holes can be accurately detected by the proposed hole-detection algorithm.

WSNs are extensively used in monitoring applications such as humidity and temperature sensing in smart buildings. However, limited energy in a sensor's battery prevents a sensor from operating in a long term. Energy harvesting has been considered as an effective approach to address the energy limitation in sensor devices and adaptive power management is essential to energy harvesting in WSNs. The fourth paper, "Autonomous Energy Management System Achieving Piezoelectric Energy Harvesting in Wireless Sensors," by Kassan et al., presents a self-management of energy based on a Proportional Integral Derivative (PID) controller, which tunes the Microprocessor Controller Unit (MCU) to adaptively control the sensor modes based on the existing vibration in the environment in order to extend the lifetime of sensor nodes.

In the fifth paper, "Design of a Practical WSN based Fingerprint Localization System," Zou et al. proposed a practical WSN based fingerprint localization system. The proposed system covers both indoor and outdoor scenarios, and can meet the demand for seamless localization. Four measures are introduced in the system to improve fault tolerance and system efficiency, including a traffic regulation based radiomap (TRRM) establishing method, a full-overlapping clustering strategy, an adaptive feature space (AFS) algorithm, and a praxeological tracking algorithm. Hardware experiments using smart phones show that the proposed localization system can achieve a positioning accuracy of within 5 m in pedestrian tests and within 10 m in driving tests.

In the last paper, "Indoor Localization Using Smartphone Magnetic and Light Sensors: A Deep LSTM Approach," Wang et al. presented DeepML, a deep long short-term memory (LSTM) based system for indoor localization using magnetic and light sensors on smart-phones. The authors experimentally verified the feasibility of using bimodal data from magnetic and light sensors for indoor localization for closed environments where there is no ambient light. Then they designed the DeepML system, which first builds bimodal images by data preprocessing, and then trains a deep LSTM network in the offline phase. Newly received magnetic field and light data are then exploited for estimating the location of the mobile device using a probabilistic method. The effectiveness of the proposed DeepML system is verified by the extensive experiments.

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It is our hope that the papers included in this special issue present recent research advances in ad hoc networks, and will become an important reference for researchers and practitioners in the area. Finally, we hope that the readers will find this special issue timely and informative.

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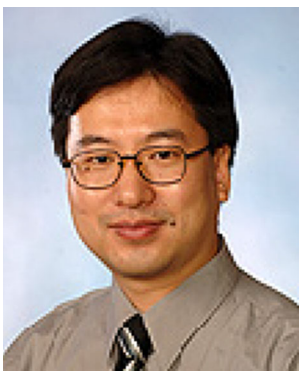

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