4-2014

Ubiquitous data-centric sensor networks

Ting YANG

Peng Yung WOO

Zhaoxia WANG
Singapore Management University, zxwang@smu.edu.sg

Javid TAHERI

Hoong Chor CHIN

See next page for additional authors

Hindawi Publishing Corporation
International Journal of Distributed Sensor Networks
Volume 2014, Article ID 459768, 3 pages
http://dx.doi.org/10.1155/2014/459768

Editorial

Ubiquitous Data-Centric Sensor Networks

Ting Yang,[1] Peng-Yung Woo,[2] Zhaoxia Wang,[3] Javid Taheri,[4] Chin Hoong Choor,[5] and Guoqiang Hu[6]

[1] *School of Electrical and Automation Engineering, Tianjin University, Tianjin 300072, China*
[2] *Department of Electrical Engineering, College of Engineering and Engineering Technology, Northern Illinois University, DeKalb, IL 60115, USA*
[3] *Institute of High Performance Computing, Singapore 138632*
[4] *School of Information Technologies, University of Sydney, Sydney, NSW 2006, Australia*
[5] *Department of Civil and Environmental Engineering, National University of Singapore, Singapore 117576*
[6] *School of Electrical & Electronic Engineering, Nanyang Technology University, Singapore 639798*

Correspondence should be addressed to Ting Yang; yangting@tju.edu.cn

Received 24 March 2014; Accepted 24 March 2014; Published 14 April 2014

Ubiquitous data-centric sensor networks (U-DCSN) are a new integrated science and technology, which focus on data instead of individual sensor nodes. The network, as a dynamic database system, can accurately acquire data, perform high-performance processing of big data, and effectively access data from different users/actuators. Due this characteristic, U-DCSN hold huge potentials on service improvement in a wide range of applications and have attracted significant attention in recent years, for example, mobile cloud and consumer electronics. The modern mobile cloud, comprised of mobile devices (smart phones, tablets, and embedded sensor nodes), provides unlimited information resources, putting "cloud into a pocket." To satisfy a wide spectrum of composite applications, the dynamic network structure with heterogeneous wireless terminals requires the mobile cloud to have efficient and high fault-tolerant data transmitting and processing capability.

To ensure success of the applications under these challenges, many issues in U-DCSN need to be researched, such as anomaly detection, distributed processing and data correlation mining, smart communication protocols, data security, and privacy guarantee technologies. In this special issue, we have collected recent advances in ubiquitous data-centric sensor networks. The papers have been peer-reviewed and have been selected on the basis of their quality and relevance to the topic of this special issue.

There are four papers that focus on the communication protocols of WSN, including 3 different layers: data link layer, network layer, transport layer, and a cross-layer protocol. The paper "*Scalability dynamic multicast labels management mechanism for ubiquitous data-centric sensor networks*" proposed a novel labels dispatching mechanism for multicast services in data-centric sensor networks. Based on *Resource Reservation Protocol* (RSVP) and *Message injecting and Headward impelling* technologies, the new mechanism can effectively reduce the total number of labels and overheads, save bandwidth, and shorten the multicast tree establishing time. The authors also addressed that the scalability of the new dynamic labels management mechanism can adapt much better to ubiquitous and thick electrical advanced metering application.

The paper "*A distributed agents QoS routing algorithm to transmit electrical power measuring information in last mile access wireless sensor networks*" integrated traffic engineering and distributed agent technologies and proposed a novel distributed agents QoS routing algorithm to transmit different kinds of information flows with multi-QoS constraints. The algorithm can explore fast forward path with multiagents and guarantee transmitting quality with smooth allocating different traffic. The authors also presented the mathematical analysis to prove the algorithm's validity. With the computer simulation, the average end-to-end delay,

routing overhead, and links' bandwidth occupation ratio were computed to evaluate the algorithm performance. Coincident results showed that the proposed algorithm can provide short end-to-end transmitting delay with optimal utilized communication resource. A healthy infrastructure with load balance can effectively avoid potential congestion and bear abrupt strong traffic flows with robust capability.

The paper "*A reliable transport protocol with prediction mechanism for urgent information in wireless sensor networks*" addressed a reliable transport protocol with prediction mechanism for urgent information (PMUI) in WSNs. In PMUI, which was based on RTP-UI, the congestion control mechanism was improved, and the priority control and prediction mechanism were adopted by taking the current queue length with change rate and expected queue length with remaining length together into consideration. The congestion status of current queue was analyzed and the changing trend of the next cycle of the queue was predicted. In order to evaluate the degree of congestion, state machine was adopted by the authors. Working states of WSNs were classified into eight states in accordance with different degrees of congestion. According to the change rate of a queue and the expected change rate of a queue, different rate adjustment mechanisms and bandwidth allocation schemes were developed based on different working states. Simulation results showed that PMUI was lower than RTP-UI in both packet loss rate and the average delay for reliable transmission of urgent information.

A cross-layer protocol was proposed in the paper "*Cross-layer power-control-based real-time routing protocol for wireless sensor networks*" to solve contradictions between real-time applications of wireless sensor networks and limited energy of nodes. In the proposed CLPCA algorithm, Power-Control-Based Real-time Routing Protocol (PCBRRP) was designed, and the transmission power of the node was adjusted dynamically to increase the energy efficiency. The next hop node can be selected via the link quality of the communication and the residual energy of every node. Simulation results showed that the energy consumption of the network was reduced while the real-time end-to-end data transmission is guaranteed.

The other two papers research on the self-organized topology in WSN. The paper "*Distributed k-coverage decision scheme for system deployment in mobile sensor networks*" aims at the sensor nodes' coverage problem, which is a key issue for WSNs as an efficient topology structure that significantly affects the quality of service and lifetime of network. In this paper, the authors studied the sensor deployment problem and proposed novel distributed decision schemes to guide sensor movement to achieve k-coverage deployment. The kth order Voronoi diagram was used to discover the regions that do not meet the k-coverage requirement. Then, two different movement strategies, MCCA and GCA, were designed to determine the optimal location of each mobile sensor. Simulation results showed that the proposed algorithm can reach the high coverage with few executive rounds, and the scale of the network had little effect on the performance of their algorithms, as the sensors used only local information with their neighbor and the movements are conducted within the local area.

The paper "*A betweenness calibration topology optimal control algorithm for wireless sensor networks*" researched on the topology optimal control (TOC) problem in WSNs. Usually, the physical topology of WSNs is usually a strongly connected topology, because any two sensor nodes can connect if they are placed in each other's wireless communication range. For information service, sensor nodes should frequently receive and process data from its large number of neighbors, which will consume great amounts of energy. Shocking wireless channel collision also causes low throughput and high loss packets ratio during data transmission. To improve the transmission performance and save scarce energy, a logical topology generating from physical one is necessary for the self-organized WSNs. Based on the complex network theory, the paper proposed a novel *Betweenness Addition Edges Expansion* algorithm (BAEE). With betweenness calibration, BAEE algorithm expanded the minimum cost edges to optimize the network topology. Two performance metrics-connectivity robustness function $R(G)$ and efficiency function $E(G)$ were utilized to evaluate the network capability of the robustness and invulnerability. $R(G)$ is the parameter to measure topology connectivity and $E(G)$ is the parameter to evaluate the network exchanging information capability. Based on the simulation under various random failures and intentional attack scenarios, BAEE can effectively optimize WSNs' topology and improve the network's robust connectivity and extremely efficient exchanging information capability.

Effective data query and location are the other great important issues for ubiquitous data-centric sensor networks. The paper "*An exact top-k query algorithm with privacy protection in wireless sensor metworks*" aimed at the top-k query problems and proposed an ETQFD algorithm based on filter and data distribution table with privacy protection. The algorithm can help enquirers seek the k highest or shortest reported values and their corresponding source nodes. The proposed algorithm used conic section privacy function to prevent the disclosure of the real data and then to promise the security of nodes in network. In this proposal, each node in WSN used data distribution table to reflect the distribution of its own data and kept exact filter to just return data which is possibly to be the result of the query, so as to reduce the energy cost of network and prolong network lifetime. In addition, data of node was packaged with a privacy protection function based on conic section. The algorithm's performance was examined with a number of parameters using synthetic datasets. Performance analysis and simulation results illustrated that ETQFD was energy-efficient and can prolong the network lifetime. At the same time, privacy of data in the proposed algorithm was also guaranteed.

It is notable that, besides the above key techniques, these papers also discussed U-DCSN's wide range of applications. The paper "*Scalability dynamic multicast labels management mechanism for ubiquitous data-centric sensor networks*" described the novel dynamic multicast labels management mechanism that can be applied in advanced metering infrastructure of smart grid. The distributed agents QoS routing algorithm in the paper "*A reliable transport protocol with*

prediction mechanism for urgent information in wireless sensor networks" can be utilized in monitoring renewable electrical generators' instantaneous voltage and power parameters and effectively solve last mile accessing communication in electrical power system. The paper "*Scalability dynamic multicast labels management mechanism for ubiquitous data-centric sensor networks*" studied the effective data query and location technique with privacy protection, which is very useful in the public and privacy cloud computing and cloud services.

Acknowledgments

Achieving such a high quality of papers would have been impossible without the huge work that was undertaken by the editorial board members and external reviewers. We take this opportunity to thank them for their great support and cooperation. This special issue was also sponsored by the National program of international S&T cooperation (no. 2013DFA11040) and the National Natural Science Foundation of China (no. 61172014).

Ting Yang
Peng-Yung Woo
Zhaoxia Wang
Javid Taheri
Chin Hoong Choor
Guoqiang Hu