Theme issue on advances in the Internet of Things: identification, information, and knowledge

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The Internet of Things (IoT) brings traditional Internet industry and society with new trends and promising technologies. Realizing the full potential of the IoT requires solving serious technical and business challenges, such as identification of things, organization, integration and management of big data, and the effective use of knowledge-based decision systems. These challenges, and more, are the focus for the International Conference on Identification, Information and Knowledge in the Internet of Things (IIKI), which provides a dedicated forum for international experts from the world to discuss their views on the current trends, challenges, and state-of-the-art solutions related to various issues in the IoT. This issue is in collaboration with the international event the international workshop on identification, information, and knowledge in the IoT (IIKI2014) held in Beijing, China (<http://ireg.bnu.edu.cn/IIKI2014/>) and addresses on hot topics relevant to data, information, and knowledge in the IoT.

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Following a review process, we accepted sixteen papers from IIKI2014 for this theme issue. Each of the papers was peer-reviewed by at least two experts in the field. In the following, we provide a brief introduction to each paper.

The paper “Wearable Training System with Real-Time Biofeedback and Gesture User Interface” by Anton Umek, Sašo Tomažič, and Anton Kos presents a wearable training system designed to facilitate the learning process of proper movement patterns in sports training with a gesture user interface and real-time biofeedback. A flexible system architecture, including several different system versions, is proposed to deal with the diverse number of possible applications. An application for golf swing training is also developed to verify the proposed real-time biofeedback training system, and field test results show that the developed system can be used as an efficient tool.

The paper “Secure Friend Discovery Based on Encounter History in Mobile Social Networks” by Hongjuan Li, Yingwen Chen, Xiuzhen Cheng, Keqiu Li, and Dechang Chen introduces a secure friend discovery mechanism based on encounter history in mobile social networks which can help people make friends with like-minded strangers nearby by exploring the fact that sharing encounters indicate common activities and interests. Unlike most existing works that either rely on a trusted centralized server or existing social relationships, the proposed algorithm is designed in an ad hoc model with no such limitation and the design is more suitable and more general for mobile social scenarios. Extensive theoretical analysis and experimental study are conducted, and the results indicate that proposed scheme is feasible and effective for privacy-preserving friend discovery in mobile social networks.

The paper “The Dissemination Distance of Mobile Opportunistic Networks” by Xia Wang, Shengling Wang, et al., investigates how far the data can reach within time

t (i.e., the dissemination distance), which reveals the tempo-spatial data dissemination properties of mobile opportunistic networks. The investigations adopt the Brownian motion model and the Levy mobility to characterize the movement patterns of nodes in the network. We select the Brownian motion model because it can be viewed as a limiting case of the random walk mobility model and the markovian mobility model, and thus our analytical results can be easily extended to these mobility models. We select the Lévy mobility since the movements of nodes are usually driven by human beings carrying the devices, and the Lévy mobility can closely mimic the walks of human beings, which makes our analysis more practical. In detail, we obtain the bounds of the distribution of the dissemination distance for the one-copy case and the multiple-copy case when nodes move with the Brownian motion and the Lévy mobility, which provide the potential of mobile opportunistic networks to support the services that may involve time and location-sensitive data dissemination.

The online anomaly detection has been propounded as the key idea of monitoring fault of large-scale sensor nodes in IoT. The paper “A New Online Anomaly Learning and Detection for Large-Scale Service of Internet of Thing” by JunPing Wang, Qiuming Kuang, and Shihui Duan presents a new online anomaly learning and detection mechanism for the large-scale service of IoT which uses the reversible-jump MCMC learning to online learn anomaly free of dynamics network and service data. The experiment results show the accuracy in forecasting dynamics network and service structures from synthetic data.

The paper “Interference-Controlled D2D Routing Aided by Knowledge Extraction at Cellular Infrastructure towards Ubiquitous CPS” by Qinghe Du, Houbing Song, Qian Xu, Pinyi Ren, and Li Sun proposes the interference-controlled D2D routing designs underlying cellular networks to support multi-hop D2D transmissions and thus enhancing the flexibility of CPS. Algorithms are proposed for two D2D networking scenarios: Maximum Rate towards Destination (MR-D) routing algorithm for the scenario sharing uplink spectrum and a MR-D Advanced (MR-DA) routing algorithm for the scenario sharing downlink spectrum. Both algorithms have low computational complexity and thus meaningful for practical systems.

The paper “Non-invasive stress recognition considering the current activity” by Mikhail Sysoev, Matevž Pogačnik and Andrej Kos aims to determine the stress level in a noninvasive way to the maximum extent possible by analyzing behavioral and contextual data received from the only source being a smartphone containing the data gathered in real-life situations. Android application was developed in the paper as a means for the current activity type identification.

Security issues are still open challenges and should be addressed to achieve enhanced safeguard for the IoT. The paper “C2MP: Chebyshev Chaotic Map Based Authentication Protocol for RFID Applications” by Zhihua Zhang, Huanwen Wang, and Yanghua Gao proposes a Chebyshev chaotic map-based authentication protocol (C2MP) for the RFID applications. According to the BAN logic, security formal analysis is performed based on the message formalization, initial assumptions, anticipant goals, and logic verification. It indicates that the proposed C2MP is suitable for universal RFID applications.

The paper “Power Consumption Prediction of Web Services for Energy-efficient Service Selection” by Jin Liu, Jiaming Jiang, et al., proposes a Virtual Power Meter Supported Power Consumption Prediction method for WSS (VPMSPCP) which facilitates choosing appropriate services to minimize wasteful electrical energy from the overall environment of SOC applications. Experiments show that VPMSPCP performs well in improving energy saving in WSS.

The paper “A Three-Dimensional Sub-Region Query Processing Mechanism in Underwater WSNs” by Zhangbing Zhou, Riliang Xing, and Walid Gaaloul proposes a sub-region query processing mechanism to address the challenge of exploration of vast ocean volume with smart things under the water and form the underwater wireless sensor networks. Experimental evaluation shows that our technique is more energy efficient when the network topology is relatively steady.

The paper “SShare: A Simulator for Studying and Evaluating Decentralized SPARQL Query Processing” by Jing Zhou, Qi Huang, and Weifeng Xie proposes a simulator—SShare—that bridges Jena, a Java framework that supports querying RDF data with SPARQL, and ns-3 (Network Simulator 3), a discrete-event network simulator using C++ and Python, which can submit any proper SPARQL query that involves RDF data of interest scattered around distributed hosts, evaluate important performance metrics obtained at the network level, and finally get visualized results.

The paper “A Video Cloud Platform Combining Online and Offline Cloud Computing Technologies” by Weishan Zhang, Liang Xu, et al., proposes a general cloud-based architecture and platform that can provide a robust solution to intelligent analysis and storage for video data and implement it using Hadoop platform and Storm platform. The proposed architecture can handle continual surveillance video data effectively, where real-time analysis, batch processing, distributed storage, and cloud services are seamlessly integrated to meet the requirements of video data processing and management. The evaluations show that the proposed approach is efficient in terms of performance, storage, and fault tolerance.

The paper “Mobility Aware Routing in Delay Tolerant Networks” by Lichen Zhang, Zhipeng Cai, Junling Lu, and Xiaoming Wang proposes a novel Mobility Prediction based Routing (MPR) scheme for DTNs, in which the spatial information of nodes and contact transitivity are both taken into account. Specifically, a time homogeneous semi-Markov process model is proposed to describe node mobility. The simulation results show that the proposed MPR scheme substantially improves delivery ratio and reduces delivery latency compared with traditional DTN routing schemes.

The paper “Chinese Social Media Analysis for Disease Surveillance” by Xiaohui Cui, Nanhai Yang, et al., proposes a new method of Chinese social media analysis for disease surveillance which is validated by the Chinese Sina micro-blog data collected from September 2013 to December 2013. The results show that a high classification precision of 87.49 % in average has been obtained.

The paper “Multi-Objects Scalable Coordinated Learning in Internet of Things” by JunPing Wang, Qiuming Kuang, and Shihui Duan proposes cooperative multi-objects meta-level learning of IoT based on the maximum potential loss of coordination. Multi-object meta-level coordinated learning algorithm defines an interaction measure that allows objects to dynamically estimate the potential utility loss of coordination with any cluster of objects. The interaction mechanism makes each object compute their beneficial coordination set in different situations, and makes the best use of their limited communication resource to cooperative multi-objects meta-level learning process. The experiments with the smart

agriculture data set demonstrate that the proposed scheme is effective and robust.

The paper “A Novel Verification Method for Payment Card Systems” by Abdulrahman Alhothaily, Arwa Alrawais, Xiuzhen Cheng, and Rongfang Bie introduces a new cardholder verification method using a multi-possession factor authentication with a distance-bounding technique. It adds an extra level of security to the verification process and utilizes the idea of distance bounding which prevents many different security attacks. The proposed method gives the user the flexibility to add one or more extra devices and select the appropriate security level. The proposed method mitigates or removes many popular security attacks that are claimed to be effective in current card-based payment systems, and that it can help to reduce fraud on payment cards.

The paper “IoT Enabled Web Warehouse Architecture: A Secure Approach” by Rashid Mehmood, Maqbool Uddin Shaikh, Rongfang Bie, Hussain Dawood and Hassan Dawood presents a secure web service oriented architecture of the web warehouse (WWh), which can improve the scalability and availability of WWh and enhance secure analysis services for human and IoT. Experiments show the proposed architecture is more reliable, scalable and secure compared with previous works.

Hereby, we would like to take this opportunity to thank all authors for their contributions. We thank all reviewers for their time, effort, and expertise for reviewing the papers. Finally, we would also like to express our honor to serve as the guest editors of this issue.