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EDITORIAL

Advancing researches on IoT systems and intelligent applications

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1 Introduction

During recent years, researchers have been witnessing the fast development of Internet of Things (IoT). Recent interests in future IoT systems arise from the big volumes of data produced from millions of networked devices in the IoT which is the most important basis for the high intelligence of the future IoT systems. It also leads to a variety of challenging characteristics of the IoT systems, such as capability, adaptability, resiliency, safety, security, and usability. To meet these challenges, various cutting-edge technologies and tools are required to analyze and extract useful knowledge from vast and diverse data streams, for the purpose of attaining more benefits of IoT. Especially, innovative solutions on technologies of identification, information, and knowledge systems are sought to attain throughput goals within efficiency constraints for orders of magnitude improvements.

The International Conference on Identification, Information and Knowledge in the Internet of Things (IIKI) addresses on the state-of-the-art solutions and current trends related to various issues of the IoT systems and intelligence applications. This theme issue is in collaboration with the international event IIKI 2016 (business.bnu.edu.cn/IIKI2016/) held on Oct. 20–21, 2016, Beijing, China. Also, we accept several articles from open calls.

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2 Review of the contributions

Thirteen articles are selected for this issue and the topics include IoT architectures and services, network security and privacy issues in IoT, network operation and management for IoT, network communication, and intelligent applications of IoT in sports and healthcare, and financial big data analysis.

Wang et al. study protecting query privacy with differentially private k-anonymity in location-based services [1]. Nowadays, location-based services (LBS) are facilitating people in daily life through answering LBS queries. However, privacy issues including location privacy and query privacy arise at the same time. Existing works for protecting query privacy either work on trusted servers or fail to provide sufficient privacy guarantee. The authors combine the concepts of differential privacy and k-anonymity to propose the notion of differentially private k-anonymity (DPkA) for query privacy in LBS. They recognize the sufficient and necessary condition for the availability of 0-DPkA and present how to achieve it. For cases where 0-DPkA is not achievable, the authors propose an algorithm to achieve eDPkA with minimized ϵ. Extensive simulations are conducted to validate the proposed mechanisms based on real-life datasets and synthetic data distributions.

Lu et al. study routing based on user social activity for cognitive radio networks [2]. Social activities of primary users (PUs) and secondary users (SUs) affect actual accessible whitespace in cognitive radio networks (CRNs). However, the impacts of primary activities on available whitespace have been extensively investigated due to the dominating priority of PUs, while the impacts of secondary activities on actual accessible whitespace have been ignored. The authors propose an approach to incorporate the primary and secondary activities in the analysis and decision of the accessible whitespace. Firstly, they approximate primary activity probability based

on the real datasets of mobile phone usage records, and then the spectrum opportunity between a pair of communication SUs is deduced based on primary activities. Secondly, they infer the access probability limit of SUs successfully accessing the whitespace according to the primary activity probability, and depict the secondary activity probability from the views of social activity patterns and social networks respectively. Furthermore, the actual accessible probability of whitespace is given by introducing the competitions among SUs. Finally, a greedy routing algorithm is proposed to verify the idea which considers the accessible whitespace and the distance to the destination. Experiment results based on the real datasets demonstrate the correctness of analysis and the advantages of the proposed algorithm.

Cheng et al. propose a framework for recovering tasks across devices using eye tracking [3]. A user task is often distributed across devices, and users move between heterogeneous devices and have to deal with task resumption overhead from both physical and mental perspectives. To address this problem, the authors create Smooth Gaze, a framework for recording the user's work state and resuming it seamlessly across devices by leveraging implicit gaze input. In particular, they propose two techniques, smart watching and smart posting, for detecting which display and target region the user is looking at, and transferring and integrating content across devices respectively. In addition, they design and implemented a cross-device reading system *SmoothReading* that captures content from secondary devices and generates annotations based on eye tracking, to be displayed on the primary device. They conduct a study that showed that the system support information seeking and task resumption, and could improve users' overall reading experience.

Du et al. propose a novel method named Banded Choropleth Map to visualize statistical data with spatiotemporal information of choropleth map [4]. Because of the disability in visualizing statistical data with spatiotemporal information of choropleth map, the authors propose a novel method—Banded Choropleth Map (BCM). The technique makes use of space filling, splits sub-regions with equal width or area, then fills partitions with different colors. It can utilize limited screen space more sufficiently than small multiples. It can also preserve context more clearly than animation. Based on the technique, the authors make a formal evaluation to find the efficiency of BCM in doing global task and local task under different factors.

Zhang et al. propose a wearing-independent hand gesture recognition method based on Electromyographic (EMG) armband [5]. EMG armband with electrodes mounted around the user's forearm is one of the most ergonomic wearable EMG devices and is used to recognize fine hand gesture with great popularity. Definitely, the distributions of signal differ greatly in different wearing position of armband based on the physiological characters of EMG, which will cause the performance decline and even the inapplicability of the recognition model built in one position. Hence, the authors propose a wearing-independent hand gesture recognition method based on EMG armband. To eliminate the influence of wearing positon, Standard Space is proposed in this paper. Based on the sequential features of EMG in different scales, the wearing position of armband is predicted and helps unify the original features to the proposed space. Then with the unified signals, fine hand gesture can be recognized accurately and robustly with lightweight Random Forest (RF). The experimental results showed that the recognition accuracy of the proposed method was 91.47% approximately. And compared with the method without fine feature extraction and feature space unification, the performance was improved by 10.12%.

Wang et al. study the design and empirical evaluations of 3D positioning techniques for pressure-based touch control on mobile devices [6]. The previous three degrees of freedom (DOF) 3D touch translations require more than one finger (usually two hands) to be performed, which limits their usability on mobile devices that need one hand to be held in most occasions. Given that the pressure sensitive touch screen will become ubiquitous in the near future, they authors presented a pressure-based 3DOF 3D positioning technique that only uses one finger in operating. The authors collect the normal force of the touch pressure and use it to represent the depth value in 3D translating. Then they conduct several groups of tightly controlled user studies to conclude: (1) how different strategies of pressure recognition will affect 3D translating and (2) how is the performance of the pressure-based manipulation compared to the previous two-fingered technique. Finally, they discuss some guidelines to help developers in the design of the pressure-sensing technique in 3D manipulations.

Kos et al. propose a prototype named *SmartSki* for biofeedback applications in skiing [7]. Miniature sensors are already integrated into various sport equipment. A combination of body-attached sensor devices and sensors integrated into the sport equipment, together with an adequate sensor fusion algorithm, can help with developing better sport's gear, speed up the learning process and improve the skill level and performance. The paper presents the *SmartSki* system including *SmartSki* prototype, measuring equipment, and several *SmartSki* applications. The *SmartSki* system is functionally tested and verified by a group of alpine skiing experts through several snow tests during the period of 1 year. The snow test results are used to improve the prototype and extract several important skiing parameters that are used in various feedback applications; for example, in a trainer feedback system or in a real-time biofeedback system for the skier. The authors are confident that the *SmartSki* can offer many benefits to

recreational skiers, ski equipment manufacturers, ski schools, coaches, and even professional skiers.

Wang et al. propose CRPD which is a novel clustering routing protocol for dynamic wireless sensor networks [8]. A wireless sensor network (WSN) consists of a large number of static or mobile, low-cost, and low-power sensor nodes. And energy is one of the most important factors that should be considered. In this paper, the authors propose CRPD to reduce energy consumption and improve energy efficiency through clustering and routing algorithms. The basic idea is to periodically update the network topology, select the node with larger degree and high residual energy as the cluster head to be responsible for data aggregation and transmission. With the nodes moving, joining, and choosing the optimal clustering radius, the energy load of the whole network can be evenly distributed to each sensor node, which can prolong the network lifetime. Extensive simulations show that CRPD is more energy-efficient than the existing protocols.

Jia et al. study dynamic cloud resource management for efficient media applications in mobile computing environments [9]. Single instruction-set architecture (single-ISA) heterogeneous multi-core processors (HMP) are superior to symmetric Multi-core processors in performance per watt. They are popular in many aspects of the Internet of Things, including mobile multimedia cloud computing platforms. One single-ISA HMP integrates both fast out-of-order cores and slow simpler cores, while all cores are sharing the same ISA. The quality of service (QoS) is most important for virtual machine (VM) resource management in multimedia mobile computing, particularly in Single-ISA heterogeneous multi-core cloud computing platforms. Therefore, in this paper, the authors propose a dynamic cloud resource management (DCRM) policy to improve the QoS in multimedia mobile computing. DCRM dynamically and optimally partitions shared resources according to service or application requirements. Moreover, DCRM combines resource-aware VM allocation to maximize the effectiveness of the heterogeneous multi-core cloud platform. The basic idea for this performance improvement is to balance the shared resource allocations with these resources requirements. The experimental results show that DCRM behaves better in both response time and QoS, thus proving that DCRM is good at shared resource management in mobile media cloud computing.

Sun et al. propose a novel stock recommendation system using *Guba* sentiment analysis [10]. Investment recommendation has been one of the hottest topics in the finance area which can help investors to get more profits and to avoid loss. Existing recommendation systems mostly depend on analysis of trading data and company profit prediction. Though many works show that there is a positive correlation between investors' sentiment and the finance market trends, few recommendation theories have been built based on sentiment. The primary reason is the difficulty to measure investors' sentiment. In this work, a novel stock recommendation system is developed based on a proposed theory concerning the correlation between Guba-based sentiment of the retail investors and the stock market trends in China. To verify four hypotheses of the theory, a novel method is proposed to measure the investors' sentiment by exploiting the large volumes of emotion enriched texts posted in Guba, which is online social platform for individual investors to share news and opinions concerning their favorite stocks. Results shows the correctness of the proposed theory: (1) there is a positive correlation between Guba-based sentiment and the stock market trends; (2) the higher the post volumes and agreement, more proficiency the bullishness would be; and (3) a long-lasting negative Guba-based sentiment indicates the arrival of the bear market. The proposed recommendation system consists of three criteria accordingly to ensure the portfolio to meet requirements of the theory. Finally, experiments are implemented using the real data of Chinese stock market from March 2009 to March 2016 and the results show the effectiveness of the proposed system in recommending lucrative stocks and the theoretical cumulate profit is about eight times of the CSI300 in the period.

Yan et al. study the discrete PSO-based workload optimization in virtual machine placement [11]. Virtual machine placement has great potential to significantly improve the efficiency of resource utilization in a cloud center. Focusing on CPU and memory resource, this paper presents SOWO—a discrete particle Swarm Optimization based Workload Optimization approach to minimize the number of active physical machines in virtual machine placement. The experiment results show the usability and superiority of SOWO. Compared with the OpenStack native scheduler, SOWO decreases the physical machine consumption by at least 50% and increases the memory utilization of physical machine by more than two times.

Ping et al. study accurate and energy-efficient boundary detection of continuous objects in duty-cycled wireless sensor networks [12]. With the development and wide adoption of industrial wireless sensor networks to support various domain applications, the boundary detection of continuous objects has become an important research challenge, where improving the accuracy of boundary and reducing the energy consumption are the first-class factors to be considered. To address this challenge, this article proposes a two-stage boundary faces detection approach, where sensor nodes are deployed in a dense fashion, and the network is duty-cycled. Specifically, when the occurrences of events are recognized, the boundary faces of continuous objects are determined through planarization algorithms. Sensor nodes

contained in the boundary faces are examined, where their sensory data are estimated using spatial interpolation methods. Certain sensor nodes are selected to be woken up, only when their sensory data suggest that they should be candidates of boundary sensor nodes. Consequently, the size of boundary faces is reduced, and this coarse-to-fine refinement procedure iterates until all sensor nodes contained in the boundary faces have been examined. Experimental evaluation result shows that the refinement procedure can refine the boundary through reducing around half of the initial boundary faces area.

Mehmood et al. study effective cancer subtyping by employing density peaks clustering by using gene expression microarray [13]. Discovering similar groups is a popular primary step in analysis of biomedical data, which cannot identify manually. Many supervised and unsupervised machine learning and statistical approaches have been developed to solve this problem. Clustering is an unsupervised learning approach, which organizes the data into similar groups, and is used to discover the intrinsic hidden structure of data. In this paper, the authors use clustering by fast search and find of density peaks (CDP) approach for cancer subtyping, and identification of normal tissues from tumor tissues. In additional, they also address the preprocessing and underlying distance metrics' impact on finalized groups. They have perfumed the extensive experiments on real world and synthetic cancer genes expression microarray data sets and compared obtained results with state-of-the-art clustering approaches.

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