
Preface

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Biographical notes: Yinong Chen received his Dr. rer. nat. from the Karlsruhe Institute of Technology (KIT), Germany in 1993. He obtained his postdoctoral research from the KIT and LAAS-CNRS, France. From 1994 to 2000, he was with the Wits University at Johannesburg, South Africa. He joined Arizona State University in 2001 and is a Senior Lecturer and Director of IoT/Robotics Education Lab. His primary research interests are in service-oriented computing, robot as a service, internet of things, and computer science education. He has (co-)authored ten books and over 200 technical papers in these areas.

1 Introduction

Smart city is a collection of services that include the physical services provided by the city and the technologies supporting the services. Smart city highlights the growing importance of information and communication technologies (ICTs), and social, economic, and environmental capital in profiling the competitiveness of modern cities. In this special issue we selected six papers, which constitute an overview of the important technologies in smart city, service provision, healthcare, communication and security, road traffic, and smart user interface.

2 Visual development of IoT and robotics applications

The first paper of the special issue presents a survey on the key technologies supporting smart city development, including internet of things (IoT), event-driven programming, service-oriented computing, cloud computing, fog computing, parallel computing and big data processing, and artificial intelligence. These technologies range from hardware to software and from computation to communication. A development environment Visual IoT/Robotics Programming Language Environment (VIPL) is introduced, which applies computational thinking to program IoT and robots. VIPL can be used to demonstrate and teach various smart city technologies discussed in this special issue.

3 Container-as-a-service architecture

The second paper is built on service-oriented computing, cloud computing and big data processing. It involves WDSL, SOAP, and RESTful services. It uses the Business Process Execution Language (BPEL), as well as Hadoop Distributed File System (HDFS) system. The big data

collected in a smart city environment makes the application more and more data-driven. However, data collection and its analysis are often collaborative and are separated and executed by different vendors. Owing to the volume and for security and privacy reasons, data migration can be difficult. To build a bridge between data owners and data analysers, service migration is applied instead, which forms the infrastructure, applications and services for different vendors. In this paper, a container-as-a-service (CaaS) framework for data processing in a smart city environment is presented. The design of a multi-layered container service construction and deployment environment is given. It employs the BPEL business workflow orchestration technologies in this environment to implement the solution. By using containers, local cluster resources are virtualised and isolated to simplify the creation and deployment of multiple applications autonomously across multiple vendor systems. Inside a container, computational tasks and worker processes are encapsulated into web services, in order to leverage service-based workflow technologies to develop timely and effective workflows in a smart city environment. A use case of smart transportation is studied to validate the usefulness and evaluate the performance of the presented architecture. Results show that the approach can be beneficial to the scientific tasks in regard to its flexibility and reusability.

4 Healthcare systems

The third paper is on healthcare systems. Smart cities are transforming many sectors and activities of society in our daily lives using the latest technologies, including big data processing and artificial intelligence. The healthcare systems will have new functionalities to improve the quality of life of its citizens. Electronic health records are an essential component of healthcare systems. They are valuable for medical practice and research, but much of the information is recorded as unstructured free text.

Knowledge extraction from unstructured text in electronic health records is a problem that is well-documented, but still not totally resolved. Knowledge extraction is challenging owing to medical language's ungrammatical and fragmented constructions. This paper presents the implementation of a unique framework for knowledge extraction based on linked open data for clinical documentation (KE-LODC). It generates accurate and high quality triples, which transform unstructured text from clinical documentation into well-defined and ready-to-use linked open data for diagnosis and treatment. These triples form the ontology of the knowledge. The name entity recognition and disambiguation (NERD) is introduced in the system, because it proved to be more precise than other available tools in entity recognition. The framework is proved to produce a large number of highly qualified triple candidates, which improves the likelihood of better classification in ontology. Furthermore, the paper evaluates the proposed framework and compares its precision and recall with two benchmark algorithms. The results show that KE-LODC performs better.

5 Behaviour and security

A smart city is based on the infrastructure of computer hardware and software. Software behaviour monitoring is an important part of the software credibility and system security, as unexpected or abnormal software behaviour could cause large financial and economic losses. Software behaviour modelling methods can be divided into three categories: static analysis, dynamic analysis, and hybrid analysis. The fourth paper in this special issue presents a hybrid software behaviours analysis method based on the behaviour template (SABT), which builds a behaviour template to detect software malicious behaviour based on a function transfer map and minimum function blocks according to the context of source code. In the existing research, many methods used state transfer diagrams to build software behaviour models. The proposed method in this paper is based on the corresponding relationship between the functions and system call sequence, which ensures that the malicious behaviour detection is more accurate. Compared with the traditional methods, such as N-gram, FSA, Var-gram, SABT can obtain a higher coverage of the code and can detect abnormal behaviour more effectively and efficiently.

6 Road traffic

The fifth paper is on the design and evaluation of efficient traffic systems. The intersections are major points of conflict for road users and the key parts of the urban road network. It is necessary to redesign and reconstruct some intersections to improve capacity and safety. This paper presents the methodology for estimating the boundary of a road network and studies the traffic impact and

improvement of intersections. The main contributions of the paper are:

- Models are developed for two types of correlation. Between two adjacent intersections: the degree of saturation and free-flow travel time are studied; and between any two intersections in the network: the degree of correlation is analysed using a Laplacian matrix algorithm.
- A new method for estimating a road network boundary is proposed.
- Two measures are adopted to evaluate the boundary of road networks: the minimum average cut degree of correlation and the minimum traffic influence on intersections outside the boundary.

A case study based on a real city road network is used to demonstrate the models and methods developed in this paper. The results of the case study confirm the validity of the proposed approach.

7 Surveillance and image processing

The last paper is on video and image processing, which is a signature task of many big data and artificial intelligence applications in smart city environments. Such applications include finding persons of interest, tracking vehicles on toll roads and any traffic rule violations. Image processing also finds many medical diagnosis and treatment applications, such as disease pattern recognition and robotic surgery. Different image fusion techniques have been proposed to decompose source images, from morphological methods to wavelet-based methods. Owing to the presence of noise and the limitation of each technique, until now no image fusion technique can provide the perfect image.

A novel integrated image fusion approach is proposed in this paper. For speeding up the clustering process, a K-means clustering algorithm is conducted. Then an online dictionary learning algorithm is used in the clustered image data. The key contributions of this paper include:

- It proposes a novel integrated sparse representation framework for image fusion that combines the image-patches clustering and online dictionary learning method.
- The original image does image patches clustering first. Then the dictionary-learning method is applied to each image patch cluster to obtain a sub-dictionary. Comparing with one learned dictionary of the original image, multiple learned sub-dictionaries can help to get a more accurate fused image.
- An online dictionary is used in sparse representation process and can extract more discriminative features.

The comparison experiments with the existing approaches demonstrated that the proposed solution had a better performance in visible and infrared image fusion.