

Handbook of Smart Cities

Muthucumaru Maheswaran • Elarbi Badidi
Editors

Handbook of Smart Cities

Software Services and Cyber Infrastructure



Springer

Editors

Muthucumaru Maheswaran
School of Computer Science
McGill University
Montreal, QC, Canada

Elarbi Badidi
CIT
UAE University
Al Ain, UAE

ISBN 978-3-319-97270-1 ISBN 978-3-319-97271-8 (eBook)
<https://doi.org/10.1007/978-3-319-97271-8>

Library of Congress Control Number: 2018961431

© Springer Nature Switzerland AG 2018

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

Cities around the world are under immense pressure to accommodate growing populations and address environmental challenges. One idea many cities have started pursuing to address this problem is to leverage Internet technologies and the forthcoming 5G to develop a suite of city-scale cyber-physical infrastructures dubbed smart cities. The major objective of smart city projects is to create sustainable, environmentally friendly cities that can provide services to the residents in the most efficient manner. Smart cities could improve on existing services such as transportation or provide new types of services such as governance that were not available before. The scope of smart cities is ever-changing as new projects around the world are deployed and experiences are gleaned from those projects. Cities manage many critical infrastructures such as transportation, waste management, water resource management, and building services that are ripe for enhancement in a smart city context.

Smart city concept is gaining momentum because of the widespread availability of many technological building blocks such as cloud computing, superfast wireless networking, and Internet of Things. In smart city deployments, sensors and actuators that generate and consume massive volumes of data under diverse formats and ontologies will be integrated into the overall system. The data created by the participating devices need to be appropriately classified and related so that duplication and conflicts can be minimized.

This book provides a glimpse of the research projects that are underway in smart cities and examination of the critical issues relevant for smart cities. The material is targeted toward researchers, developers of smart city technologies, and graduate students in the fields of communication systems, computer science, and data science. The book includes 14 chapters from researchers working on various aspects of smart city-scale cyber-physical systems.

The first three chapters deal with infrastructures for smart cities. Chapter 1 provides a survey of the Internet of Things and computer networking technologies at the smart city scale. It describes some typical smart city projects that apply IoT to provide smart services mainly in three areas: smart mobility, smart sustainability, and smart living. In particular, it discusses the unique challenges posed when

devices and sensors are connected in massive numbers to cloud computing backend services and the security challenges of IoT deployments in smart cities. Chapter 2 examines the roles of 5G and IoT in future smart city scenarios and postulates some future challenges that could emerge in that context. Chapter 3 describes the use of clouds and sensor-based devices for monitoring and managing smart facilities like bridges and other smart applications.

The emerging multidisciplinary field of urban informatics is the focus of Chap. 4. A variety of issues ranging from IoT infrastructure, mobile crowdsensing, big data management, knowledge management of IoT applications, to IoT security and privacy are discussed in this chapter.

Casinos are a major part of city-scale entertainment. The evolution of casinos in a 5G smart city scenario is discussed in Chap. 5. In particular, it presents a design of an integrated casino and entertainment architecture called 5G ICEMO, which relies on the future 5G micro-operators model. It proposes a business model for Integrated Casinos and Entertainment (ICE) in future smart cities and analyzes how the technologies of cloud computing, fog computing, analytics, access control, security handling, virtual reality, robots, etc. can be used to develop ICE micro-operators. Chapter 6 reports on a small-scale prototype smart parking deployment using IoT hardware and cloud computing. The chapter describes the experiment and the experiences obtained through the experiment.

Vehicular crowdsensing is the focus of Chap. 7. It examines two types of vehicular crowdsensing: public and private. In public crowdsensing, a global database is created using the sensing activity, whereas with private crowdsensing individual queries are mapped to the participants who could solve the crowdsensing tasks. The chapter describes a model for personalized vehicular crowdsensing.

Context-sensitive computing is a key smart city technology. In Chap. 8, a new architecture for deploying context-sensitive computing at the scale of smart cities is described. Chapter 9 describes intelligent mobile message support for smart cities based on reinforcement learning. Chapter 10 describes the data integration problem with urban data streams.

Large-scale interoperability is a fundamental problem in smart cities. It could be tackled in many different ways including the creation and adoption of standardized protocols. In Chap. 11, an interesting idea called asymmetric interoperability is presented to tackle the interoperability problem. The chapter addresses the issue of services interoperability in the context of smart cities and the Internet of Things where services are implemented in the IoT devices. These devices typically interact in large numbers while exhibiting different characteristics.

Video surveillance is already gaining popularity. With smart cities, they could see even broader deployment. Chapter 12 surveys technologies and infrastructures for video surveillance management in a smart city. It provides typical examples of smart cities' applications that use video surveillance. It also describes on-premises and cloud-based solutions and the experimental testbed used to evaluate the performance of both solutions in terms of CPU, memory, storage, and bandwidth usage.

Chapters 13 and 14 focus on transportation in smart cities. The management of electric vehicles in smart cities is the focus of Chap. 12, while information

presentation to nudge citizens toward greener transportation choices is examined in Chap. 13. Chapter 12 surveys the research efforts concerning electric vehicles charging by focusing on the issue of selection of suitable charging stations. It describes three main configurations: centralized, distributed, and hybrid. It also describes how mobile edge computing could be used for the selection of charging stations.

Smart buildings play an important role in smart cities. They have a significant impact on the overall functioning of the smart cities. In Chap. 15, a novel energy harvesting approach to deploy wireless sensing is described. Approaches like this could pave the way toward creating maintenance-free remote deployments in smart buildings and possibly in smart cities.

Montreal, QC, Canada
Al Ain, UAE

Muthucumaru Maheswaran
Elarbi Badidi

Contents

Internet of Things (IoT) Infrastructures for Smart Cities..... 1
Quang Le-Dang and Tho Le-Ngoc

The Role of 5G and IoT in Smart Cities 31
Attahiru Sule Alfa, Bodhaswar T. Maharaj, Haitham Abu Ghazaleh,
and Babatunde Awoyemi

**Leveraging Cloud Computing and Sensor-Based Devices
in the Operation and Management of Smart Systems** 55
Shikharesh Majumdar

**Mobile Computing, IoT and Big Data for Urban Informatics:
Challenges and Opportunities** 81
Anirban Mondal, Praveen Rao, and Sanjay Kumar Madria

**5G Wireless Micro Operators for Integrated Casinos
and Entertainment in Smart Cities** 115
Da-Yin Liao and XueHong Wang

An IoT-Based Urban Infrastructure System for Smart Cities 151
Edna Iliana Tamariz-Flores, Kevin Abid García-Juárez, Richard Torrealba-
Meléndez, Jesús Manuel Muñoz-Pacheco, and Miguel Ángel León-Chávez

Vehicular Crowdsensing for Smart Cities 175
Tzu-Yang Yu, Xiru Zhu, and Muthucumaru Maheswaran

**Towards a Model for Intelligent Context-Sensitive Computing
for Smart Cities** 205
Salman Memon, Richard Olaniyan, and Muthucumaru Maheswaran

**Intelligent Mobile Messaging for Smart Cities Based
on Reinforcement Learning** 227
Behrooz Shahriari and Melody Moh

Asymmetric Interoperability for Software Services in Smart City Environments	255
José C. Delgado	
Management of Video Surveillance for Smart Cities.....	285
Nhat-Quang Dao, Quang Le-Dang, Robert Morawski, Anh-Tuan Dang, and Tho Le-Ngoc	
Intelligent Transportation Systems Enabled ICT Framework for Electric Vehicle Charging in Smart City	311
Yue Cao, Naveed Ahmad, Omprakash Kaiwartya, Ghanim Puturs, and Muhammad Khalid	
Green Transportation Choices with IoT and Smart Nudging.....	331
Anders Andersen, Randi Karlsen, and Weihai Yu	
Energy Harvesting in Smart Building Sensing: Overview and a Proof-of-Concept Study	355
Aristotelis Kollias, Colton Begert, and Ioanis Nikolaidis	
Building a Data Pipeline for the Management and Processing of Urban Data Streams	379
Elarbi Badidi, Nouf El Neyadi, Meera Al Saeedi, Fatima Al Kaabi, and Muthucumaru Maheswaran	
Index.....	397