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The Internet of Things for Smart Urban Ecosystems

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Preface

Nowadays, the exploitation of ICT technologies in urban environments is enabling the realization of smart infrastructures that provide enhanced digital services improving the quality-of-life of citizens and the cities' efficiency.

In this field, significant smart applications include but are not limited to smart parking, traffic management, smart lighting, structural health monitoring, air quality and pollution monitoring, health monitoring, waste management, smart grids and city energy optimization, smart urban drainage networks, building automation, and emergency detection and management.

Since all these applications share a common urban environment and common goals, they need to interact with each other and with citizens, creating a Smart Urban Ecosystem (SUE).

An SUE is a people-centric system of systems needing a tight integration between cyber and physical components for sensing, reasoning, and controlling the urban environment. In this context, The Internet of Things (IoT) constitutes an enabling technology as it bridges the gap between physical things and software components and empowers the cooperation among distributed, pervasive, and heterogeneous entities.

The development of an SUE introduces several challenges, which include heterogeneous system integration, interoperability among different technologies, fault tolerance, scalability, system maintenance, geographical and functional extensibility, social networking, mobile computing, context-aware applications and services, human-in-the-loop modeling and simulation, big data analysis, cloud- and edge-based IoT frameworks and environments, field experiments and testbeds. Moreover, the realization of an SUE requires cross-domain knowledge expertise spanning from computer science to electronic, electrical, civil, hydraulic, and energy engineering.

The main objective of this book is to provide a multidisciplinary overview of methodological approaches, architectures, platforms, algorithms, and applications for the realization of Smart Urban Ecosystems.

The book includes 15 chapters covering three main topics: (i) software architectures and platforms for SUEs, (ii) development approaches and algorithms for SUEs implementation, and (iii) applications and case studies related to specific smart infrastructures and smart cities. A short introduction to the chapters is provided below.

The Chapter "A Social and Pervasive IoT Platform for Developing Smart Environments", by Orazio Briante, Franco Cicirelli, Antonio Guerrieri, Antonio Iera, Alessandro Mercuri, Giuseppe Ruggeri, Giandomenico Spezzano, and Andrea Vinci, gives an overview of the iSapiens platform, which is a Java-based platform specifically designed for the development and implementation of Smart Environments (SEs). iSapiens exploits the Social Internet of Things paradigm that allows to dynamically discover "things" without requiring intervention from humans. iSapiens provides tools for the realization of pervasive SEs and relies on the edge computing paradigm. Moreover, the chapter reviews some SE applications built by leveraging iSapiens features.

The Chapter "Smart City Platform Specification: A Modular Approach to Achieve Interoperability in Smart Cities", by Arianna Brutti, Piero De Sabbata, Angelo Frascella, Nicola Gessa, Raffaele Ianniello, Cristiano Novelli, Stefano Pizzuti, Giovanni Ponti, proposes a development methodology and a modular and scalable multilayered ICT platform to address the problem of cross-domain interoperability in the context of smart city applications. As a distinct feature, the chapter tackles issues about interoperability on the Information and Semantic levels and provides an approach for finding the correct balance between prescriptive and elastic specifications.

The Chapter "Integrated Cyber Physical Assessment and Response for Improved Resiliency", by P. Sivils, C. Rieger, K. Amarasinghe, and M. Manic, provides a summary and analysis of crucial concepts and challenges in assessing cyber-physical degradation, heterogeneous data fusion, and visualization under a smart city IoT architecture. The main objective is to provide a basis for enhancing the effectiveness of human response to physical and cyber events.

The Chapter "On the Integration of Information Centric Networking and Fog Computing for Smart Home Services", by Marica Amadeo, Andrea Giordano, Carlo Mastroianni and Antonella Molinaro, focuses on the role that can be assumed by the Information Centric Networking (ICN) paradigm to support future Internet communications and data delivery in smart urban ecosystems, including smart home/building services. The integration of ICN with Cloud/Fog resources is also discussed in the chapter, and a reference architecture is presented as a proof-of-concept, together with a preliminary testbed.

The Chapter "Optimal Placement of Security Resources for the Internet of Things", by Antonino Rullo, Edoardo Serra, Elisa Bertino, and Jorge Lobo, deals with the problem of efficiently and effectively securing IoT networks by carefully allocating security resources in the networked area. The problem is modeled according to the game theory, and a Pareto-optimal solution is provided, in which the cost of the security infrastructure and the probability of a successful attack are minimized. In the chapter, authors make a distinction between static and mobile

networks, and address the problem of computing the best allocation plan with different approaches.

The Chapter "Embedding Internet-of-Things in Large-Scale Socio-technical Systems: A Community-Oriented Design in Future Smart Grids", by Yilin Huang, Giacomo Poderi, Sanja Šćepanović, Hanna Hasselqvist, Martijn Warnier, and Frances Brazier, focuses on the design of large-scale Socio-technical Systems (STS) relying on Internet of Things technologies. The design of such systems, especially in a complex social context like that of Urban Ecosystems, requires the use of suitable methodological approaches that have not yet entered into the mainstream of design practice. The chapter reviews the literature and presents some lessons learned in adopting an STS-based approach for the design of a community-oriented smart grid application.

The Chapter "Aggregation Techniques for the Internet of Things: An Overview", by Barbara Guidi and Laura Ricci, starts from the consideration that an Internet of Things environment can connect a very large number of sensors, so generating a huge amount of data. Aggregation techniques are required to reduce the size of data to be transmitted and stored, while maintaining a reasonable level of approximation. The chapter offers an overview of a set of aggregation techniques that can be exploited in the IoT, ranging from Space-Filling Curves to Q-digest, Wavelets, Gossip aggregation, and Compressive Sensing.

The Chapter "Swarm Intelligence and IoT-Based Smart Cities: A Review", by Ouarda Zedadra, Antonio Guerrieri, Nicolas Jouandeau, Giandomenico Spezzano, Hamid Seridi, and Giancarlo Fortino, reviews swarm intelligence-based algorithms and related smart city solutions. A swarm intelligence-based framework for smart cities is presented that uses a decentralized control over its components in order to build scalable and flexible smart cities. In addition, a set of trends on how to use swarm intelligence in smart cities, in order to make them flexible and scalable, is investigated.

The Chapter "Cost Saving and Ancillary Service Provisioning in Green Mobile Networks", by Muhammad Ali, Michela Meo, and Daniela Renga, discusses how mobile network operators are required to face huge operational costs, due to the staggering increase in mobile traffic and substantial bandwidth reliability requirements in Smart Urban Ecosystems. The chapter analyzes, for a real scenario, the notable benefits that can be achieved by combining the WiFi offloading approach, the techniques for dynamic adaptation load in a Demand Response context, and the usage of renewable energy sources.

The Chapter "Structural Health Monitoring (SHM)", by Raffaele Zinno, Serena Artese, Gabriele Clausi, Floriana Magarò, Sebastiano Meduri, Angela Miceli, and Assunta Venneri, aims at fitting the structural health monitoring into the Internet of Things. For this purpose, the chapter extensively details, through the description of a real application scenario, all the phases required for developing an effective online and real-time assessment of the structural health of a building.

The Chapter "A Smart Air-Conditioning Plant for Efficient Energy Buildings", by Roberto Bruno, Natale Arcuri, and Giorgio Cuconati, focuses on the correct management of energy fluxes in the context of prosumer systems. The goal is to

make effective the process of producing, storing and consuming energy, and increasing users' remuneration. The chapter describes a smart air conditioning system and the correspondent control strategies adopted for its management. The system is based on the employment of photovoltaic-driven heat pumps with thermal storage connected to a radiant emission system.

The Chapter "A Comprehensive Approach to Stormwater Management Problems in the Next Generation Drainage Networks", by Patrizia Piro, Michele Turco, Stefania Anna Palermo, Francesca Principato and Giuseppe Brunetti, shows how the next generation of urban drainage networks can benefit from Internet of Things and ICT technologies. The chapter describes two innovative approaches for managing drainage networks, exploiting a decentralized real-time control system and low-impact development techniques.

The Chapter "Cooperative Video-Surveillance Framework in *Internet of Things* (IoT) Domain", by A. F. Santamaria, P. Raimondo, N. Palmieri, M. Tropea, and F. De Rango, presents the main issues related to the design of an architecture for a smart cooperative video-surveillance system. The chapter shows a surveillance system based on a cooperative tracking among cameras and involves advanced techniques of detection and tracking. In addition, the chapter presents a significant use case showing how an anomaly can be detected, followed by a set of cameras, and managed by generating alerts and messages without human intervention.

The Chapter "Personal Connected Devices for Healthcare", by Adina Riposan-Taylor and Ian J. Taylor, offers a comprehensive survey on personal connected health technologies, which are fast becoming integral in a person's daily life to help improve their health and well-being. The chapter provides a broad overview of a range of devices that allow people to monitor their own health and/or provide self-therapeutic benefits using biofeedback or neurofeedback to control their own physiologic functions. Specific focus is given to the techniques adopted to provide access to data, to the software used for data integration, to connectivity issues, and to user interfaces.

The Chapter "Evacuation and Smart Exit Sign System", by V. Ferraro and J. Settino, exploits the Internet of Things for the realization of emergency evacuation systems. The chapter proposes a smart system that relies on a set of sensors and smart exit signs which are coordinated by a reliable and dynamic evacuation algorithm, which is capable of fast adapting to changing conditions during the evolution of an emergency.

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