Connected Health in Smart Cities

Abdulmotaleb El Saddik • M. Shamim Hossain • Burak Kantarci
Editors

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Editors
Abdulmotaleb El Saddik
School of Electrical Engineering and Computer Science
University of Ottawa
Ottawa, ON
Canada

Burak Kantarci
School of Electrical Engineering and Computer Science
University of Ottawa
Ottawa, ON
Canada

M. Shamim Hossain
Computer and Information Sciences
King Saud University
Riyadh, Saudi Arabia

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Preface

The book *Connected Health in Smart Cities* seeks to provide an opportunity for researchers, academics, and practitioners to explore the relationship between connected health techniques, theoretical foundations, essential services, and recent advances of solutions to problems, which may arise in a variety of problem domains of connected health in a smart city context. This book can serve as a repository of significant reference material.

This book aims to report the theoretical foundations, fundamental applications, and the latest advances in various aspects of connected services in health, more specifically the state-of-the-art approaches, methodologies, and systems in the design, development, deployment, and innovative use of multisensory systems, platforms, tools, and technologies for health management for the success of smart cities ecosystem.

The title of each of the book chapters is self-explanatory and a good hint to what is being covered. The overview of each chapter is as follows:

Chapter "Image Recognition-Based Tool for Food Recording and Analysis: FoodLog"—Maintaining food consumption and habits and analyzing food records is indispensable for the well-being of the citizen in a smart city context. To this end, FoodLog, a smart phone-based image recognition tool, is used for food recording and analysis from digital food image through image recognition or searching. FoodLog's application can be used for the management of food-related data of the athletes or sports activities. This chapter also has better insights related to improved health for healthy diet selection to control various diseases.

Chapter "A Gesture Based Interface for Remote Surgery"—At present, specially equipped vehicles or air-lifting to nearest hospitals/clinics is not affordable for the citizens in emergency cases or inadequate for areas with a large population that is remote from emergency surgical services. These vehicles can only serve a few patients or citizens every day. In this situation, there is a need for remote surgical services by skilled surgeons. Considering the above facts, this chapter discusses the application of gesture-based interactive user interfaces in performing remote endovascular surgery. The conducted experiments in the chapter demonstrate the

feasibility of the approach and also the accuracy of the robotic controller at the base of the catheter, before it enters an artery.

Chapter "Deep Learning in Smart Health: Methodologies, Applications, Challenges"—Today, deep learning is one of the emerging theoretical foundations of connected health that can support healthcare professionals to find out the hidden opportunities in healthcare data and its pattern to assist doctors in order to have better analysis for improved health care for the citizens of smart cities. Keeping the above benefits in mind, this chapter presents very good insights of how deep learning techniques can be used for smart health data analysis, processing, and prediction. It also discusses about the emerging applications of deep learning techniques in smart health from cancer diagnosis to health status predictions.

Chapter "Emotional States Detection Approaches Based on Physiological Signals for Healthcare Applications: A Review"—Emotional health is one important consideration for improving citizens' quality of life and well-being in the smart cities. With these issues in mind, this chapter discusses existing emotional state approaches using machine and/or deep learning techniques, the most commonly used physiological signals in these approaches, and existing physiological databases for emotion recognition and highlights the challenges and future research directions in this field. It also discusses about how to incorporate accurate emotional state detection wearable applications (e.g., patient monitoring, stress detection, fitness monitoring, wellness monitoring, and assisted living for elderly people) within the smart cities so that it can aid to alleviate mental disorders, stress problems, or mental health.

Chapter "Toward Uniform Smart Healthcare Ecosystems: A Survey on Prospects, Security, and Privacy Considerations"—Security and privacy consideration is of paramount importance in the connected healthcare applications for the citizens' safety and well-being in smart cities. To this end, this chapter explores the latest trends in connected healthcare applications along with enabling technologies (e.g., sensing, communication, and data processing) and solutions (e.g., low-power short-range communication, machine learning, and deep learning) that might be driving forces in future smart health care. It reports the latest cyber-attacks and threats, which could be major vulnerabilities and weaknesses of the future smart healthcare ecosystem. It concludes with the proposed solutions and their associated advantages and disadvantages of each solution and analyzes their contribution to the overall security as an integral part of the connected healthcare system.

Chapter "Biofeedback in Healthcare: State of the Art and Meta Review"—This chapter begins by discussing the scope of utilizing biofeedback technology in smart healthcare systems. It presents a brief history of biofeedback technology and highlights the sensory technology in biofeedback systems by presenting the different types of sensors and their features. Recent research of biofeedback-based healthcare systems will be explored by presenting a range of applications in different fields. A set of challenges/issues that affect the deployment of biofeedback in healthcare systems will be discussed.

Chapter "Health 4.0: Digital Twin for Health and Well-Being"—With the advances in wearable computing, smart living, and communication technologies,

personalized healthcare technology has entered a new era of healthcare industry to provide personalized proactive and preventive care in real time without being in close proximity. Digital Twins is an emerging technology to revolutionize healthcare and clinical processes. A digital twin virtualizes a hospital to have more personalized care. This chapter gives an overview of the existing literature and aims to provide an overview of existing literature on digital twins for personal health and well-being—key terminologies, key technologies, key applications, and the key gaps.

Chapter "Incorporating Artificial Intelligence into Medical Cyber Physical Systems: A Survey"—The emerging Medical Cyber-Physical Systems (MCPS) can revolutionize our connected healthcare system with high-quality, efficient, and continuous medical care for citizens of smart cities by providing remote patient healthcare monitoring, accelerate the development of new drugs or treatments, and improve the quality of life for patients who are suffering from different medical conditions, among other various applications. This chapter starts with the general description of the MCPS components and then discusses (1) how multisensory sensor devices and body sensor networks can assist in healthcare data acquisition, aggregation, and preprocessing and (2) how machine intelligence algorithms process the medical data from the previous steps to facilitate monitoring through connected healthcare systems and make self-directed decisions without much involvement of healthcare staff in a secure way to preserve the privacy of the citizens of smart cities.

Chapter "Health Promotion Technology and the Aging Population"—One of the important aspects for the success of connected health is the use of emerging healthcare technologies, which are of paramount importance in connected health services to the aging population in cities to improve the quality of care. To this end, this chapter provides an overview of assisted technologies and a survey of how the technology can be used to affect the elderly population to integrate healthier habits into their lives. The variety of accessible technologies allows individuals to use them in conjunction for their desired outcomes.

Chapter "Technologies for Motion Measurements in Connected Health Scenario"—The proactive and efficient care is one of the utmost requirements for connected health or technology-enabled care (TEC) in smart cities. For such care, smart sensing technology-based wearable solutions are essential for human motion tracking, rehabilitation, and remote healthcare monitoring. In such a context, this chapter presents an unobtrusive sensing solution (e.g., the Internet of Things (IoT)-enabled sensing) based on key enabling technologies with the aim of providing human motion measurement accompanied by motion measurement-related research and open issues. Finally, it demonstrates how the human motion measurements in motion tracking can contribute to the remote health monitoring system based on IoT and publish/subscribe communication paradigm.

Chapter "Healthcare Systems: An Overview of the Most Important Aspects of Current and Future m-Health Applications"—With the increasing number of aging population and the widespread use of mobile devices and communication technologies, citizens in smart cities would like to access the connected health

service from anywhere at any time. In this respect, the mobile health care (m-healthcare) can provide affordable care for people in a convenient, accessible, and cost-effective manner. This chapter reports an overview of a generic m-Health application along with its main functionalities and components. The use of a standardized method for the treatment of a massive amount of patient data is necessary to integrate all the collected information resulting from the development of m-Health devices, services, and applications. To this end, this chapter discusses about the requirements of a standardization in healthcare, which is supported by related international and European healthcare projects.

Chapter "Deep Learning for EEG Motor Imagery-Based Cognitive Healthcare"—Owing to the massive amounts of complex healthcare data being produced in environments, such as smart cities, deep learning and cognitive capability are necessary to the idea of connected health. Deep learning-based cognitive systems can help various stakeholders, such as medical experts, healthcare professionals, and patients to develop insights into medical data that can help improve health care and provide a better quality of life to smart city residents. Hence, this chapter leverages deep learning techniques for understanding MI EEG data. The improvement in classification accuracy for motor imagery can help impart cognitive intelligence to machines and enable smart city residents to control the environment through sensors attached to their heads. This chapter proposes novel techniques for cross-subject accuracy and achieves outstanding improvement that can usher in new concepts about these complex brain signals.

The target audience of this book includes researchers, research students, and health practitioners in digital health. The book is also of interest to researchers and industrial practitioners in healthcare industry and smart city. We would like to express our great appreciation to all the contributors, including the authors, reviewers, and Springer staff, for their kind support and considerable efforts in bringing this book to reality.

We hope that the chapters from this book will serve as a repository of significant reference material and contribute to the roadmap of emerging use of services, techniques, and technologies for connected healthcare in smart cities.

Ottawa, ON, Canada — Abdulmotaleb El Saddik
Riyadh, Saudi Arabia — M. Shamim Hossain
Ottawa, ON, Canada — Burak Kantarci

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