Preface

Pervasive healthcare environment, focusing on the integration of mobile and ubiquitous technology to reform working and living conditions for individuals and organizations in the healthcare sector, sets the stage for an innovative emerging research discipline. Healthcare systems are experiencing a variety of challenges including the prevalence of life-style related conditions, growing consumerism in healthcare, the need to empower patients with information for better decision making, requests for better tools for self-care and management of deteriorating health conditions, the need for seamless access for healthcare services via the Internet and mobile devices, and the growing costs of providing healthcare.

Mobile health (m-health) is an integral and significant part of the emerging pervasive healthcare field. M-Health contains three core components integrated into the healthcare environment. The first component is the availability of a reliable wireless architecture; the second component is the integration of medical sensor or wearable devices for monitoring; and the final component is a robust application and services infrastructure. M-Health relates to applications and systems such as telemedicine, telehealth, e-health, and biomedical sensing system. The rapid advances in information communication technology (ICT), nanotechnology, bio-monitoring, mobile networks, pervasive computing, wearable systems, and drug delivery approaches are transforming the healthcare sector and fueling the m-health phenomenon. M-Health aims to make healthcare accessible to anyone, anytime, and anywhere by elimination constraints such as time and location in addition to increasing both the coverage and quality of healthcare.

Mobile and wireless concepts in healthcare are typically related to bio-monitoring and home monitoring; however, more recently the trend to incorporate mobile technology has become more prevalent across almost the entire healthcare data acquisition task domains. Bio monitoring using mobile networks includes physiological monitoring of parameters such as heart rate, electrocardiogram (ECG), electroencephalogram (EEG) monitoring, blood pressure, blood oximetry, and other physiological signals. Alternative uses include physical activity monitoring of parameters such as movement, gastrointestinal telemetry fall detection, and location tracking. Using mobile technology, patient records can be accessed by healthcare professionals from any given location by connecting the institution's internal network. Physicians now have ubiquitous access to patient history, laboratory results, pharmaceutical data, insurance information, and medical resources. These mobile healthcare applications improve the quality of patient care. Handheld devices can also be used in home healthcare, for example, to fight diabetes through effective monitoring. A comprehensive overview of some of these mobile health applications and research has been presented in this book.

This book provides an international perspective on the benefits of mobile health technology to illustrate different examples and applications implemented in the global healthcare sector. The work features 32 contributing authors representing six countries including the United States, United Kingdom, Spain, Portugal, Italy, and Denmark. Even though the healthcare policies and governance of healthcare systems

in these countries differ, the benefits to be realized from a future of implementations of mobile health technology are not inconsistent among the countries.

The book may be divided into three major sections:

1. Mobile Health Applications and Technologies
2. Patient Monitoring and Wearable Devices
3. Context Aware Systems in Healthcare

The first section "*Mobile Health Applications and Technologies*" provides an analysis of the technology. Case studies highlighting the successes and challenges of mobile health projects offer real-world illustrations of applications and uses of mobile technologies in the healthcare sector. M-Health is a broad area transcending multiple disciplines and utilizing a broad range of technologies. "*Evaluation of Two Mobile Nutrition Tracking Applications for Chronically Ill Populations with Low Literacy Skills,"* authored by Katie A. Siek, Kay H. Connelly, Beenish Chaudry, Desiree Lambert, and Janet L. Welch, discusses two case studies that compare and contrast the use of barcode scanning, voice recording, and patient self reporting as a means to monitor the nutritional intake of a chronically ill population.

Chapter II "*Accessing an Existing Virtual Electronic Patient Record with a Secure Wireless Architecture*" by Ana Ferreira, Luís Barreto, Pedro Brandão, Ricardo Correia, Susana Sargento, and Luís Antunes presents the concept of a virtual electronic patient records system that enables the integration and sharing of healthcare information within heterogeneous organizations. The VEPR system aims to alleviate the constraints in terms of physical location as well as technology in order to access vital patient records. The use of wireless technology attempts to allow access to patient data and processing of clinical records closer to the point of care. The ubiquitous access to information can minimize physical as well as time constraints for healthcare, enhancing users' mobility within the institution. The next chapter in this section entitled "*Personal Health Records Systems Go Mobile: Defining Evaluation Components*" is authored by Phillip Olla and Joseph Tan. It provides an overview of Mobile Personal Health Record (MPHR) systems. A Mobile personal health record is an eclectic application through which patients can access, manage and share their health information from a mobile device in a private, confidential, and secure environment.

Chapter IV focusing on "*Medical Information Representation Framework for Mobile Healthcare"* was written by Ing Widya, HaiLiang Mei, Bert-Jan van Beijnum, Jacqueline Wijsman, and Hermie Hermens. This chapter describes a framework which enables medical information such as clinical, vital signs and professional annotations to be manipulated in a mobile, distributed and heterogeneous environment despite the diversity of the formats used to represent the information. It further proposes the use of techniques and constructs similar to the internet to deal with medical information represented in multiple formats. Chapter V is "*A Distributed Approach of a Clinical Decision Support System Based on Cooperation*," authored by Daniel Ruiz-Fernández and Antonio Soriano-Payá. This chapter discusses an architecture that supports diagnosis based on the collaboration among different diagnosis-support artificial entities or agents and the physicians themselves. The proposed systems architecture, which was tested in a melanoma and urological dysfunctions diagnosis, combines availability, cooperation and harmonization of all contributions in a diagnosis process. Chapter VI, the final chapter in this section, "*Managing Mobile Healthcare Knowledge: Physicians' Perceptions on Knowledge Creation and Reuse*" was authored by Teppo Räisänen, Harri Oinas-Kukkonen, Katja Leiviskä, Matti Seppänen, and Markku Kallio. This chapter focuses on mobile access to medical literature and electronic pharmacopoeias, aiming to demonstrate that using these recourses effectively may help physicians to communicate and col-

laborate as well as learn and share their experiences within their user community. The chapter presents a case study of the users of Duodecim mobile healthcare information system.

The second section presents research on P*atient Monitoring and Wearable Devices*. Chapter VII, the first chapter in this section, is titled "*Patient Monitoring in Diverse Environments*" and is authored by Yousef Jasemian. This chapter discusses the benefits of recording of physiological vital signs in patients' real-life environment by a mobile health system. This approach is useful in the management of chronic disorders such as hypertension, diabetes, anorexia nervosa, chronic pain, or severe obesity. The author explored the issues and limitations concerning the application of mobile health system in diverse environments, emphasizing the advantages and drawbacks, data security and integrity while also suggesting approaches for enhancements. The following chapter, Chapter VIII, is titled "*Monitoring Hospital Patients using Ambient Displays*" authored by Monica Tentori, Daniela Segura, and Jesus Favela. This chapter explores the use of ambient displays to promptly notify hospital workers of relevant events related to their patients. To highlight the feasibility and applicability of ambient displays in hospitals, this chapter presents two ambient displays aimed at creating a wearable connection between patients and healthcare providers. The authors also discuss issues and opportunities for the deployment of ambient displays for patient monitoring. Chapter IX is titled "*Towards Easy-to-uUse, Safe, and Secure Wireless Medical Body Sensor Networks*" and is authored by Javier Espina, Heribert Baldus, Thomas Falck, Oscar Garcia, and Karin Klabunde. This chapter discusses the use of wireless body sensor networks (BSNs), which are an integral part of any pervasive healthcare system. It discusses suitable wireless technologies and standardization dedicated to BSN communication and highlights key challenges in the areas of easy-of-use, safety, and security that hinder a quick adoption of BSNs. To address the identified challenges, the authors proposed the use of body-coupled communication (BCC) for the automatic formation of BSNs and for user identification and presented a lightweight mechanism that would enable a transparent security setup for BSNs used in pervasive healthcare systems.

Chapter X is titled "*Sensing of Vital Signs and Transmission Using Wireless Networks*" and is authored by Yousef Jasemian. This chapter investigated the feasibility using wireless and cellular telecommunication technologies and services in a real-time m-health system. He based his investigation, results, discussion and argumentation on an existing remote patient monitoring system. His results indicated that the system functioned with a clinically acceptable performance, and transferred medical data with a reasonable quality, even though the system was tested under totally uncontrolled circumstances during the patients' daily activities. Both the patients and the healthcare personnel who participated expressed their confidence in using the technology. The author also suggested enhancing features for more reliable, more secure, more user-friendly and higher performing M-Health system in future implementations.

Chapter XI, "*Towards Wearable Physiological Monitoring on a Mobile Phone"* by Nuria Oliver, Fernando Flores-Mangas, and Rodrigo de Oliveira discusses the experience gained from using mobile phones as a platform for real-time physiological monitoring and analysis. The authors presented two mobile phone-based prototypes that explore the impact of real-time physiological monitoring in the daily life of users. The first prototype is called HealthGear; this is a system to monitor users while they are sleeping and automatically detect sleep apnea events; the second is TripleBeat, a prototype that assists runners in achieving predefined exercise goals via musical feedback and two persuasive techniques: a glanceable interface for increased personal awareness and a virtual competition.

The third and last section focuses on research and on the theme of *Context Aware Systems* in the healthcare arena. Chapter XII, the first chapter in this section, is titled "*A Framework for Capturing Patient Consent in Pervasive Healthcare Applications*." It is authored by Giovanni Russello, Changyu Dong, and Naranker Dualy and describes a new framework for pervasive healthcare applications where the patient's consent plays a pivotal role. In the framework presented, patients are able to control the

disclosure of their medical data. The patient's consent is implicitly captured by the context in which his or her medical data is being accessed. Context is expressed in terms of workflows. The execution of a task in a workflow carries information that the system uses for providing access rights accordingly to the patient's consent. Ultimately, the patient is in charge of withdrawing consent if necessary. Chapter XIII is titled "*Technology Enablers for Context-Aware Healthcare Applications*" authored by Filipe Meneses and Adriano Moreira. This chapter discusses how context and location can be used in innovative applications and how to use a set of solutions and technologies that enable the development of innovative context and location-aware solutions for healthcare area. The chapter highlights how a mobile phone can be used to compute the level of familiarity of the user with the surrounding environment and how the familiarity level can be used in a number of situations. The increasing availability of mobile devices and wireless networks, and the tendency for them to become ubiquitous in our dally lives, creates a favourable technological environment for the emergence of new, simple, and added-value applications for healthcare. Chapter XIV is titled "*Modeling Spatiotemporal Developments in Spatial Health Systems"* is authored by Bjorn Gottfried and discusses Spatial health systems and the support these systems can provide to disabled people and the elderly in dealing with everyday life problems. The author also addresses every kinds of health related issues that can develop in space and time. The work focuses on how spatial health systems monitor the physical activity of people in order to determine how to support the monitored individuals. Chapter XV, the final chapter in this section, titled, "*Context-Aware Task Distribution for Enhanced M-Health Application Performance*" authored by Hailiang Mei, Bert-Jan van Beijnum, Ing Widya, Val Jones, Hermie Hermens. This chapter describes the importance of context-aware mobile healthcare systems. Due to the emergence of new medical sensor technologies, the fast adoption of advanced mobile systems to improve the quality of care required by today's patients context aware healthcare systems is clearly needed . The authors propose an adaptation middleware that consists of a task assignment decision mechanism and a task (re-) distribution infrastructure. The decision mechanism represents task assignment as a graph mapping problem and searches for the optimal assignment given the latest context information.

The research presented in this book is important due to the emergence of pervasive computing and health care systems that provide quality patient care services. By reviewing the diverse chapters presented a healthcare provider or practitioner will learn about the potential applications that will become the norm in the future.