Preface

Over the last decade, there has been a dramatic increase in the utilization of wireless technologies in healthcare systems as a consequence of the wireless, ubiquitous, and pervasive communications revolution. The emerging information and wireless communication technologies in health and healthcare lead to e-Health systems, also known as e-Healthcare, which have been drawing increasing attention in the public and have gained strong support from government agencies and various organizations. Originally, telemedicine, the use of electronic communication for the exchange of images, data, audio, or other information to provide healthcare services between remote locations, was a rapidly growing application of wireless technologies.

Nowadays, the advances in wearable computing, bioengineering, wireless sensors networks, mobile devices, and wireless communications have paved the way to new definitions of e-Health systems, moving from original telemedicine systems to the integration of existent specialized medical technologies with pervasive technologies. In order to make future e-Health systems a reality, a strong cooperation among several diverse research areas in engineering is vital. These areas include research in bioengineering, Body Area Networks (BANs), wearable sensors, microprocessors, wireless communications, wired communications, data mining, data processing, security, and many other diverse areas. For example, one of the major research challenges in the design of future healthcare systems is the design of reliable wireless and pervasive communications protocols. Wireless communications for healthcare systems calls for innovation in Information and Communications Technology to facilitate reliable, comprehensive, and high quality healthcare. The requirements for safe signal propagation characteristics, low network latency, low packet loss, high quality image and video transmission, and the need for safe, secure, and dependable operation imposes a number of research challenges on the design of the e-Health Systems.

The new technologies in this era offer many advantages over old healthcare systems; from efficiencies in the hospital clinic to new ways to monitor patient health and disease progression. They also open up possibilities of new health enhancement systems for the future. However, the design of e-Health systems comes with a set of newly emerged challenges due to requirements for accuracy, security, and privacy of electronic health information, strict regulatory compliance, low network latency, low packet loss, high availability, small device size with power constraints, and multi-hop short-distance communications.

The goal of this book is to explore the developments and current/future challenges in the successful deployment of future e-Healthcare Systems. The book combines the research efforts in different disciplines from pervasive wireless communications, wearable computing, context-awareness, sensor data fusion, artificial intelligence, neural networks, expert systems, databases, security and privacy. This book will be a pioneer reference in this field and will resonate sharply with researchers who have been craving a unified reference in the field of e-Healthcare Systems.
The book is divided into four sections; each section groups several related e-Healthcare research topics, starting with a brief introduction to current e-Healthcare Systems and challenges, and finally, concluding this book with general research problems of E-Healthcare systems.

**Section 1: Introduction to E-Healthcare Systems**

The first section of the book, Introduction to e-Healthcare Systems, presents introductory materials that are preparatory for what we describe in the rest of the book. It details the basic infrastructure and architecture of e-Healthcare systems highlighting the possible challenges associated with such an architecture. Also, innovative e-Healthcare applications for clinicians and the use of RF-ID in the current e-Healthcare systems are discussed.

The developing world faces numerous challenges in realizing the infrastructure and technical expertise required to adopt mobile health solutions and applications. In Chapter 1, e-Healthcare challenges in the developing world are discussed and existing problems and risks in realizing Mobile Health applications and services are highlighted.

The adoption of e-Healthcare system does not seem to be flourishing as expected due to various barriers. One such barrier is an inadequate level of legal protection or unawareness of availability of laws and regulations that address the e-Healthcare system. Chapter 2 investigates the present status of law relating to privacy, product liability, jurisdiction of courts in e-health care disputes, and professional negligence.

Computer-based applications at diverse healthcare sites have led to many improvements over a prolonged period of time. Some of these advances include efficiency (in comparison to paper based data), effectiveness (in terms of support in the various processes carried out at the healthcare setting), and more categorized data. Chapter 3 discusses the possible benefits and challenges offered by Web-based applications for clinicians.

Healthcare organizations are exploiting RFID to maximize use of tools and equipment, keep tabs on medicinal drugs, boost patient flow, and plug gaps in patient safety. Chapter 4 discusses a number of singular RFID applications that have been successfully developed or are in late development stages in the healthcare industry.

**Section 2: Security and Privacy Issues in E-Healthcare Systems**


The field of implantable medical devices (IMDs) has witnessed a rapid proliferation and increased success in the past ten years. This noticeable success in the field of IMDs and the major advancements in wireless sensor network algorithms and applications, have stimulated the emergence of specialized biological networks termed as Body Sensor Networks (BSNs). Chapter 5 presents a comprehensive survey of the state of the art research in the field of Body Sensor Networks security and privacy.

Personally identifiable healthcare information automated by the healthcare industry can be stolen, intercepted, altered, and misused. Acceptable safeguards, therefore, have to be in place in order to ensure the privacy and protection of this information. Chapter 6 discusses how without governmental intervention, it seems unlikely that the healthcare industry will voluntarily implement any safeguards.
Our society has been facing considerable challenges in recent years. Increasing traffic congestion, energy scarcity, climate change and many other issues have taken a turn for the worse and need urgent attention. One such area is providing quality healthcare to people, the primary focus of Chapter 7. Chapter 7 presents a novel perspective on securing Pervasive Health Monitoring Systems called Cyber Physical Security (CYPSec) solutions.

**Section 3: Real Life Efforts towards the Deployment of E-Healthcare Systems**

The third section of the book, Real Life Efforts towards the Deployment of E-Healthcare Systems, presents various attempts towards the successful implementation of e-healthcare applications and systems.

As mobile phones become more powerful and perform more complex interactions between mobile devices to resident software and other server-based software, they have been recognized as effective tools for telemedicine, and the merging of the Internet and mobile computing introduces new opportunities and challenges in telemedicine sector. Chapter 8 describes the development and implementation of Android-based telemedicine system for patient-monitoring.

Chapter 9 describes international humanitarian efforts for the deployment of technology in healthcare centers in developing countries. The study in the chapter reports the proceedings for providing a comprehensive system that will define public health in villages.

Patients find it hard to keep track of scheduled meetings with medical personnel. This could have adverse impacts on patients’ health, especially for those with chronic diseases. Chapter 10 presents the design, deployment, and evaluation of a mobile-based medical alert system (MAS) for managing diseases where adherence or compliance is paramount for effective treatment.

Different expert systems for diagnosing diseases have been developed; however, they are either stand-alone or Web-based systems. Chapter 11 presents a disease diagnosis system that can be accessed via mobile phones to cater for the needs of the vast majority of users in places where healthcare is inadequate.

The advanced worldwide use of mobile and wireless networks has made them widely used in many current and emerging healthcare services. Chapter 12 provides an overview of existing portable medical devices. The chapter then focuses on portable automated agitation detection where the design and prototyping of a device capable of portable wireless agitation detection is detailed.

**Section 4: Open Research Challenges in E-Healthcare Systems**

The fourth and last section of the book, presents a number of open research challenges in e-Healthcare Systems including ambient assisted living, communication protocols, and real time E-healthcare systems research.

Chapter 13 proposes a novel in-network solution to prioritize the transmission of patient vital signs using wireless Body Area Networks. The solution relies on a distributed priority scheduling strategy based on the current patient condition and on the vital sign end-to-end delay and reliability requirements.

In e-Healthcare systems, the knowledge of terminal capabilities is essential for service provision. Chapter 14 focuses on the issue of dynamic adaptation of medical services and content to the terminal capabilities of the requesting device so that with a generic service design, all possible client devices can be served.
Various projects within the Ambient Assisted Living (AAL) domain have proven that remarkable results can be achieved by using wireless sensor technology and mobile devices for data collection. Chapter 15 gives an overview about AAL, healthcare related standards and state of the art approaches for data integration.

Quality of Service (QoS) is the ability to provide certain priorities to different classes of e-health applications, users, or data flows, or to guarantee a certain level of performance to a data flow such as a required bit rate, delay, jitter, packet dropping probability and/or bit error rate. Chapter 16 is dedicated to the development and investigation of IEEE 802.16, a technology which would allow healthcare services with good QoS.

The recent increased interest in distributed and flexible wireless pervasive applications has drawn great attention to WNCS (Wireless Networked Control Systems) architectures based on WSANs (Wireless Sensor and Actuator Networks). Chapter 17 is concerned with the performance evaluation of a cooperative routing algorithm QBAR (Queue Based Ad hoc Routing algorithm) for wireless e-Healthcare systems.

One common and primary vision of e-Health is to achieve “seamless” interoperability between e-Health systems. Chapter 18 presents a service-based approach that utilizes domain ontologies, combined with extensible problem models, enriched with domain terminology and knowledge services, to enable autonomous data governance and semantic interoperability.

Epilepsy is one of the most common serious neurological disorders, affecting about 60 million people worldwide. Chapter 19 presents the applications, requirements, solutions, and further research problems for a Centralized Real-time E-Healthcare System (CREHS) for Epilepsy patients.

Gait analysis is the systematic study of human walking. Chapter 20 proposes an accurate full-body wireless wearable human locomotion tracking system using UWB radios with specific application to clinical gait analysis.

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