Telehealthcare Computing and Engineering

TELEHEALTHCARE COMPUTING AND ENGINEERING

Principles and Design

Fei Hu (ed.)

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To Yang Fang and Gloria (Ge Ge) .....

I always love you two .....

Preface

Healthcare has become a top priority in many countries. One of the most efficient ways to reduce healthcare cost is to reduce in-person or in-hospital medical visits through the tele-Healthcare systems. Tele-healthcare for remote patient monitoring and diagnosis would largely benefit our society (1) by enhancing accessibility to care for underserved populations (such as in rural/remote areas), (2) by containing cost inflation as a result of providing appropriate care to patients in their homes, and (3) by improving quality as a result of providing coordinated and continuous care for patients and highly effective tools for decision support. Especially, tele-healthcare system plays an important role when we face deadly viruses today. For example, in 2009 the Swineflu virus has spread from Mexico to over 40 countries. Without good control, its threat could be as threatening as the epidemic flu that occurred in Spain in 1919, killing millions of people.

Although Tele-Healthcare Computing and Engineering (TCE) is such an important field, unfortunately there are very few books covering the following three important components in TCE (see the following figure): (1) Healthcare principles: the medical principles need to be known first before a practical medical engineering design

begins. For instance, how do we know a heart-beat signal pattern is abnormal? (2) Computer Networking: how does a wireless network remotely transmit the sensed medical data back to a hospital? (3) Embedded System: how do we design tiny medical sensors (with hardware/software) to collect medical data?

This book has a comprehensive coverage on TCE principles and application. It is based on the latest research outcomes from the top TCE experts in the world. It has both basic, tutorial-oriented description of TCE system architecture and detailed computing science/engineering design on TCE hardware and software. It has over 100 figures/tables to provide graphic interpretations of some profound concepts. Moreover, each chapter has complete discussion on problem background, state-of-the-art, suggested solutions and future development trends in this topic.

Features of The Book

Compared to other healthcare books, this book has the following special features:

(1) Emphasize both computing science and engineering design: Since TCE is a multi-disciplinary field (refer to Figure 1), we have invited over 20 scientists and engineers who have worked in TCE for a long term to describe all importance aspects in both science principles (such as healthcare signal analysis) and engineering design (such as medical sensor design). Such a science/engineering integration is important to TCE understanding since it needs to be built on both software and hardware.

(2) Explain both entire TCE system and individual components: This book has 4 parts. Part I introduces the entire TCE system architecture from remote health monitoring and TCE networking viewpoints. The system is built on the latest technologies such as e-textiles, wireless sensor networks, wireless and mobile networks, on-site medical imaging

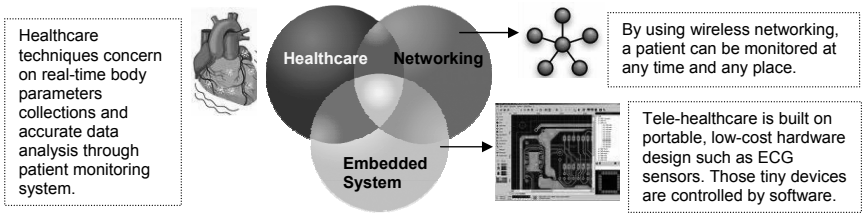

Figure 1. TCE is an emergent multi-disciplinary field.

collections and processing, etc. The large amount of nuts and bolts of a complete TCE system, including medical sensors, implantable medical devices (IMDs), ECG signal analysis, medical pattern recognition algorithms, etc., will also be explained through circuit design and algorithms. Such a system/components integration approach makes our book suitable to both TCE R&D managers and design engineers.

(3) Covers both basic principles and deep research/development (R&D) details: The collected chapters could be tutorial nature or profound discussion of R&D design. Most chapters have discussions of both basic principles and deep knowledge. For example, when we discuss the medical sensor design, we first provide general guidelines on medical devices circuit design procedure; then we go to the concrete engineering design detail of each sensor component such as materials, CPU, healthcare signal sensing, and signal transmission.

Targeted Audiences

This book is suitable to the following types of readers:

(1) *College students*: This book can serve as the textbook or reference book for college courses on TCE. The TCE courses could be offered in Computer Science, Electrical and Computer Engineering, Information Technology and Science, or other departments.

(2) *Researchers*: Because each chapter is written by the top TCE researchers, the contents are very useful to researchers (such as graduate students and professors) who are interested in TCE fields.

(3) *Computer Scientists*: We have provided many computing algorithms on medical signal processing in this book. Thus computer scientists could refer to those principles in their own design.

(4) *Engineers*: We have also provided many useful medical device design principles. Thus company engineers could use those principles in their product design.

Book Architecture

This book uses 4 parts to cover the most important aspects in TCE. Those 4 parts include system, hardware, software and security issues.

Part I: System: This part describes the entire system architecture of TCE from networking and health monitoring viewpoints. We will introduce the latest technologies (especially sensor networks and mobile platforms) and their importance in TCE systems.

Part II: Hardware: This part describes the design principles of important medical devices such as sensors, RFID, IMDs, etc. We will provide the circuit design and electronics details.

Part III: Software: This part focuses on the medical signal processing and pattern recognition in order to better analyze the collected medical signals and find the disease patterns.

Part IV: Security: Medical system should be designed to overcome all types of attacks (such as sensor data eavesdropping) and to protect the patients' privacy. This part will discuss those security issues.

Disclaimer

We have tried our best to provide credits to all cited publications in this book. Due to the time limit, this book could have some errors or missing contents. And we sincerely thank to all authors who have published TCE materials and directly/indirectly contributed to this book through our citations. If you have questions on the contents of this book, please contact the editor {Fei Hu: fei@eng.ua.edu} and we will correct the errors and thus improve this book in the future editions.

Contents

List of Contributors

Augustyniak, Piotr: AGH University of Science and Technology, 30, Mickiewicz Ave., 30-059 Krakow, Poland. E-mail: august@agh.edu.pl

Chen, Hongda: Qinghua East Road No.35A, Beijing, 100083, China P.R. E-mail: hdchen@semi.ac.cn

Fong, Bernard: C936 Harbourfront Horizon, 8 Hung Luen Road, Hung Hom Bay, Kowloon, Hong Kong. E-mail: bfong@ieee.org

Hu, Fei: Electrical and Computer Engineering, The University of Alabama P. O. Box 870286Tuscaloosa, AL 35487 USA. Telephone: (205) 348-1436; Fax: (205) 348-6959. E-mail: fei@eng.ua.edu

Jacobs, Peter G.: National Center for Rehabilitative Auditory Research, Portland VA Medical Center, Mail stop: NCRAR, P5F-1793710 SW US Veterans Hospital Road, Portland, Oregon 97239. Tel. 503-220-8262 x55949; Fax. 503-721-1402; Cell. 503-358-2291. E-mail: pete@jacobstechnologies.com

Kurihara, Yosuke: 3-3-1 Kichijoji-kitamachi, Musashino-shi, Tokyo 180-8633, Japan. E-mail: yosuke-kurihara@st.seikei.ac.jp

López, Gregorio: Avenida de la Universidad 30, Leganés, Madrid, Spain, 28911. E-mail: gregorio.lopez@uc3m.es

Martin-Clemente, Ruben: Signal Processing and Communications Department, Engineering School (University of Seville), Descubrimientos Avenue, 41092—Seville (Spain). E-mail: ruben@us.es

Meguerdichian, Saro: Saro Meguerdichian c/o Miodrag Potkonjak, Computer Science Department, 3532G Boelter Hall, Los Angeles, CA 90095-1596. E-mail: saro@cs.ucla.edu

Melillo, Paolo: Via G. Paisiello, 23, 80026 Casoria (NA), Italy. E-mail: paolo.melillo@unina.it

Ogirala, Ajay: 3700 O'Hara Street, 1140 Benedum Hall, Pittsburgh, PA—15213. E-mail: ajayo17@gmail.com

Orlov, Nikita V.: 251 Bayview Blvd, Suite 100, Rm 10B125, Baltimore, MD 21224. Tel. 410-558-8503; Fax. 410-558-8331. E-mail: norlov@nih.gov

Pecchia, Leandro: Department of Electrical and Electronic Engineering,Faculty of Engineering,University of Nottingham, Tower building, 1207 University Park, Nottingham NG7 2RDUK. E-mail: Leandro.Pecchia@nottingham.ac.uk

Rocchi, Laura: Department of Electronics, Computer Science and Systems, University of BolognaViale del Risorgimento 240136 Bologna, Italy. E-mail: l.rocchi@unibo.it

Sant'Anna, Anita: Intelligent Systems Lab, School of Information Science, Computer and Electrical Engineering, Halmstad University, Box 823, S-301 18 Halmstad, Sweden. Tel. +46 35167849. E-mail: Anita.Santanna@hh.se

Singh, Aditya: 2540 Dole street,Holmes Hall 483, Department of Electrical Engineering, University of Hawaii at Manoa, Honolulu, HI-96822, USA. E-mail: singha@hawaii.edu

Unay, Devrim: Electrical and Electronics Engineering, Bahcesehir University, Ciragan Cd., Osmanpasa Mektebi Sk, 4/6, Besiktas, Istanbul, 34353, Turkey. E-mail: devrim.unay@bahcesehir.edu.tr

Vacher, Michel: Laboratoire d'Informatique de Grenoble—Equipe GETALP, 41 rue des Mathématiques—Domaine Universitaire, BP 53, 38041 Grenoble cedex9, France. E-mail: Michel.Vacher@imag.fr

Ward, W. Kenneth: MD, Diabetes Center, Mailstop OP05DC, Oregon Health and Science University, 3181 SW Sam Jackson Park Rd, Portland OR USA 97239. E-mail: wardk@ohsu.edu

Wendt, James B.: James B. Wendt c/o Miodrag Potkonjak, Computer Science Department, 3532G Boelter Hall, Los Angeles, CA 90095-1596. E-mail: jwendt@cs.ucla.edu

Yang, Hui: 4202 E. Fowler Ave. ENB118, Tampa FL 33620. E-mail: huiyang@eng.usf.edu

Yang, Y. Tony: Department of Health Administration and Policy, George Mason University, 4400 University Boulevard, MS: 1J3, Fairfax, VA 22030. E-mail: ytyang@gmu.edu