Editorial Note on the Processing, Storage, Transmission, Acquisition, and Retrieval (P-STAR) of Bio, Medical, and Health Information

IEEE TRANSACTIONS ON INFORMATION TECHNOLOGY IN BIOMEDICINE (TITB) is growing both in terms of size and impact factor. While the impact factor of TITB has reached its new heights in 2008 (1.939; 2.825 for the five-year impact factor), the number of manuscripts received annually by the journal almost doubled compared to six years ago. Although we constantly reduced the acceptance rate, we were experiencing a lengthening backlog. In view of this, we made substantial efforts in the past year to clear up the queue of papers waiting for publication. We hope that by shortening the time from submission to publication, the TRANSACTIONS can attract even more high-quality papers that mark the advancements in informatics within the wide spectrum of biological, medical, and health issues.

Advanced health informatics (a collective term used in this Editorial for bio, medical, and health informatics) has been identified as an active research area with great potential. Indeed, listed as one of 14 grand challenges awaiting engineering solutions in the 21st century [1], advanced health informatics is found as a key area that can help to shape our future health model via redesigning care practice, developing personal health information systems, and networking these systems into a global one. Challenges of advanced health informatics are found in five core topics: the processing, storage, transmission, acquisition, and retrieval (P-STAR) of information from all levels of biological systems.

I. HEALTH INFORMATION ACQUISITION

Acquiring information from human body, spreading over multiple spatial and temporal scales, is the first critical challenge in advanced health informatics. Various sensing and imaging tools of different modalities are needed to acquire multiscale information, including sequences of DNA and protein molecules, structural and functional information of tissues and organs, as well as time-variant physiological signals and parameters that can be measured inside the body and on the body surface. Each of these tools has their own limitations to overcome; however, there will be some common goals that they should aim to achieve.

First, challenges remain in developing some of these techniques into ones that can be used at the point of care so as to bring health services more conveniently and immediately to the users. Microfluidic biochips for on-site disease diagnosis [2] devices that mimic the human sensory systems [3] and wearable systems for home healthcare [4] are typical developments for this purpose. Second, resolution of a number of techniques must be further improved to extract new useful information that indicates the possible development of a disease at its early stage. In addition, new information must be filtered out from a mixture of data obtained from the complex biological environment. New preprocessing and modeling methods help to improve sensitivity and specificity of acquisition tools, for example, to detect discriminatory peptide/protein patterns from a large number of mass/charge peaks (resulted from features, biomarkers, and data points) in high-resolution mass spectrometry [5] or to reconstruct superresolution images by new sampling theory [6]. Third, techniques that can track changes of the biological system in a dynamic situation are needed for advanced health informatics. Compared to the finite amount of information restrained in DNA sequences, the reversible chemical modification at multiple sites of even a single protein encodes an enormous and so far unknown capacity of information [7]. Imaging organs in motion or affected by motion such as respiration requires new methods that are different from imaging the organs in a static environment [8]. Many cardiovascular dynamics are also found to contain different information than the averaged readings taken at rest [9]. Therefore, developing new techniques that can be used in a dynamic situation can broaden the amount of information that is acquired to support healthcare decision making.

II. HEALTH INFORMATION TRANSMISSION

Seamless transmission of information by standardized protocols is required to build a health information system of multiple levels, from personal to familial, institutional, regional, national, and eventually, global. Both healthcare and conventional medical devices used at home and in the hospitals have to be linked up to servers by networks, such as WiFi, mobile network, LAN, and WAN. The call for papers on *4G Health—The Long Term Evolution of m-Health* this year is intended to assemble original and innovative contributions in the area of emerging future wireless and network technologies for next generation of m-Health systems, especially regarding applications that leverage the new broadband technologies, such as WiMAX and other long-term evolution communication systems. For established networks, security of health information is still key challenge waiting for a solution.

Amongst the different networks used for developing the health information system, the emerging body area/sensor networks (BAN/BSN) for connecting biosensors and devices worn on or implanted in an individual are most underdeveloped. Since

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BAN/BSN are extremely limited in power and memory space, a great challenge is to take into consideration the unique characteristics and resources already available to this type of network to develop a lightweight and secured solution. Although wireless radio-frequency technologies, such as Bluetooth, Zigbee, ultrawide band (UWB) are communication protocols that are frequently used in current research of BAN/BSN, their suitability for long-term continuous monitoring are questionable. A unique solution for BAN/BSN should also make use of the human body as well as clothing and accessories worn on the body. The recent development in smart fabric can serve as a new platform for connecting on-body sensors [10]–[13]. Characteristics of the human body as a communication channel should also be studied for transmitting information securely and at a low cost [14], [15]. For example, physiological-signal-based key agreement (PSKA) is a scheme proposed for enabling secure intersensor communication within a BAN in a usable (plug-n-play, transparent) manner without the need of initialization or predeployment [16].

III. Health Information Processing

Fusion of the massive, heterogeneous set of health information requires new techniques. One of the greatest challenges is to develop and integrate gene regulatory/structural/functional/physiological models to support in making individualized healthcare decisions. A pioneering work in the related topic is the Physiome Project of the International Union of Physiological Sciences (IUPS) [17]. Since the human body is an extremely complex system where some of the useful information is difficult to access, developing physiological models are essential for putting pieces of information of different scales and modality together to draw the conclusion. These models help clinicians to better understand the underlying mechanisms of disease development such that personalized healthcare decisions can be made at an early stage when subjects are still apparently healthy.

IV. Health Information Storage and Retrieval

Challenges in information storage and retrieval are closely related to each other. Health information must be shared in a way that can be later used by different care practitioners, and possibly, outside the original context in which it was acquired. Interoperability is a general term to describe sharing information accurately and conveniently between different electronic health record systems, as well as between electronic health records and healthcare decision-supporting system or research databases. As participatory care is gaining more interest, retrieval of health information by nonprofessionals, for example, over the Internet is also becoming an important research topic. Technologies advancement in grid computing helps to securely merge resources, which are operated independently, at the global level over public networks.

Each of the aforementioned topics has its own technical grand challenges that remain to be solved. By this Editorial, we look forward for more original contributions to TITB in all five core topics—P-STAR of information—for advanced health informatics.

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