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Biomedical Technology: The transforming paradigm of Healthcare Industry with its impact on Patient Monitoring System

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ABSTRACT

Telehealth technology, which leverages wireless and enterprise networking, is changing the model of how we think about going to the doctor. The ability to automatically and accurately capture and record patient data from biomedical devices can improve workflow and efficiency. In this paper we are going to discuss a patient monitoring system based on an existing industry standard communication network, using standard hardware components and software technologies. The standard interfaces, and flexible signal interpretation potential.

1. INTRODUCTION

Patient monitors are the most important diagnostic devices of hospitals. During the last decade, centralized patient monitoring systems were Installed which provides the networking of several bedside patient monitors with a central monitoring station [1]. The general public believes that technology will improve health care efficiency, quality, safety, and cost. However, few people consider that these same technologies may also introduce errors and adverse events. While technology has the potential to improve care, it is not without risks. Technology has been described as both part of the problem and part of the solution for safer health care [2]. Connecting to patient monitoring systems provides a supplemental means of communicating alerts raised by the monitors. Most of the existing patient monitors belong to the so-called first generation systems with traditional and quite reliable signal interpretation capabilities. Decision support and interactivity—as a higher level of signal interpretation—are the features of the second- and third-generation monitors [3]. The future of medical device technology took a major step forward. This innovative technology allows us to extend the reach of patient care beyond the clinic walls, and opens up a new way for physicians to treat patients, with the potential for more efficient chronic disease management and better patient outcomes. In addition, this is tremendous convenience for patients and clinicians, and allows patients more security and peace of mind about their devices.

2. moderndays patient monitoring system

Modern healthcare uses technology to diagnose and treat illness in ways that were previously impossible. With an ageing global population, the demands on healthcare systems continue to grow and the need to deliver effective, yet non intrusive, hospital monitoring for in-patients with serious medical issues can help to deliver a more effective and user friendly hospital experience.

Rapid medical developments of the 20th century have enabled people in the 21st century to have a greater life expectancy. Technology is constantly offering more efficient ways to meet the needs of the current healthcare system. An aging world population dictates that healthcare systems have to treat an increasing number of patients with various states of chronic illnesses. Technology can be implemented to address the increased workload on clinical staff and hospital systems. One such area of application is the undertaking of routine medical observations industry standard –based monitoring system.

This evaluation has shown that system has potential to provide clinical staff with additional patient information at more frequent intervals than current practices and resources allow.

3. PATIENT MONITORING SYSTEM WITH BIOMEDICAL TECHNOLOGY

In spite of the improvement of communication link and despite all progress in advanced communication technologies, there are still very few functioning commercial wireless monitoring systems, which are most off-line, Monitoring is the process of observing a physical system, and control is concerned with guiding the behavior of the observed system toward some predetermined objective. The related notions of monitoring and control often brings into mind an image of a rapidly-changing system under observation, manipulated by time-critical decisions and actions.

4. THE PROPOSED SYSTEM

SYSTEM ARCHITECTURE

The evolution of wireless communication and network technologies enables remote medical services to be available everywhere in the world. In the proposed system, the number and type of medical sensors are scalable depending on individual needs. This feature allows the system to be flexibly applied in several medical applications. Furthermore, a differentiated service using priority scheduling and data compression is introduced. This scheme can not only reduce transmission delay for critical physiological signals and enhance bandwidth utilization at the same time, but also decrease power consumption of the hand-held personal server. The whole system architecture is shown in figure 1.

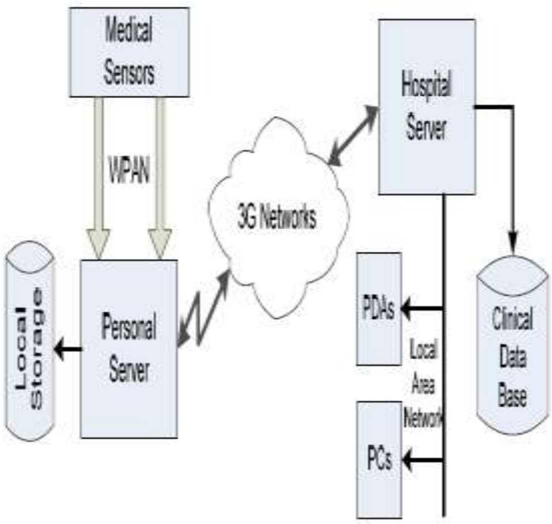


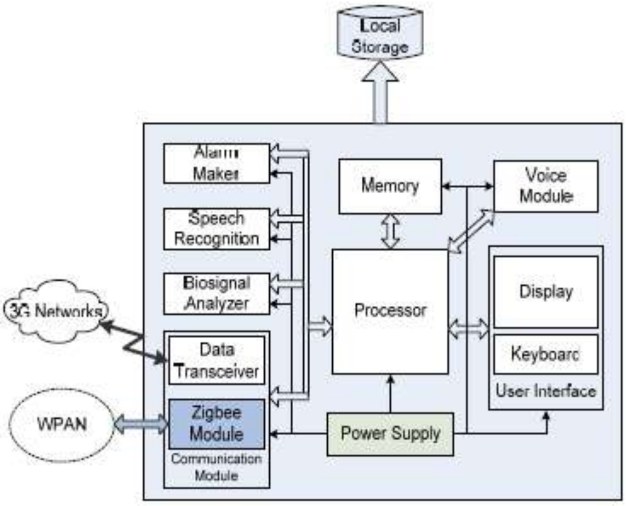
Fig. 1

It is composed of medical sensor nodes, a hand-held personal server, a hospital server and related services. In this system, medical sensor nodes are used to collect physiological signals including biosignals, medical images, and voice signals. These obtained signals are fed into the personal server through wireless personal area network (WPAN). The wireless communication between the sensor nodes and the hand-held personal server uses IEEE 820.15.4/Zigbee standard. Then the hand-held personal server processes the data and displays the results on its LCD screen. And the data can be stored in a local memory for self recording. If necessary or required, the data can be transmitted to the hospital server via 3G communication networks. With the availability of 3G networks, digitalized data and voice can be transmitted simultaneously. After arriving at the hospital server, the data are either stored in the clinical data base, or available to a clinician through a hospital's local area network (LAN). Then clinicians can analyze the physiological data and give diagnosis advices accordingly. Alternatively, when a clinician is away from the hospital, he/she still can get the data via a PDA and give diagnosis advices to the patient remotely.

THE PERSONAL SERVER

Important role in overall telemedicine system. It is designed as a hand-held unit which can be used to communicate parallelly with a series of scalable medical sensor nodes as well as a remote hospital server. It maintains a communication bridge between patients and the hospital. Medical sensors start to collect data (such as ECG) after getting the command from the personal server and then send it to the personal server via wireless personal area network (WPAN). Results (e.g. body temperature or blood pressure) can be displayed on LCD screen of the personal server. And data may be sent to the remote hospital server for further processing if necessary. The main components of the personal server are listed as follows:

- Processor & Memory module: The processor manages the connections and data flow among all modules. It also takes charge of initialization and configuration of connected medical sensor nodes.
- User Interface: The LCD screen is used for showing measurement results (e.g. body temperature) and the keyboard is used to input request from patient. For example, for heart disease patients, an ECG measurement or blood pressure testing can be taken if required.
- Communication module: This module consists of two sub modules a data transceiver and a Zigbee module, which respectively manage communicating with the hospital server
- Bio-signal Analyzer: The main tasks of the personal server are to collect and process physiological data from medical sensor nodes. Bio-signal analyzer module is used to analyze bio-signals and performs parameter extraction under the remote clinician's request. For example, among the patient's vital signals, ECG generates the highest data rate, which is about 10 kB/s. R-interval analysis can be performed to determine the peaks through setting the threshold and first derivative for a standard peak function. By transmitting certain R-intervals instead of the whole ECG waveform, the data rate can be lowered and power consumption can be reduced subsequently.
- Speech Recognition: This module is used to record voice signals and sounds from the patient especially during sleeping-time. When there are abnormal snoring sounds, alarms will be made to inform the care giver or wake up the patient himself/herself.
- Alarm Maker: If one of the physiological signals exceeds the threshold that is pre-set, this module will make alarms to inform the clinician or a care giver. Then the patient will get corresponding treatment in time.
- Voice Module: This module is used to provide voice communication between the hand-held personal server and the hospital. Conversations can be started by either side. With the help of this module, the patient can communicate with the physician more directly and effectively.



5. PATIENT CARE TECHNOLOGY AND SAFETY

The general public believes that technology will improve health care efficiency, quality, safety, and cost. However, few people consider that these same technologies may also introduce errors and poor actions. While technology holds much promise, the benefits of a specific technology may not be realized due to four common pitfalls:

- Poor technology design that does not adhere to human factors and ergonomic principles
- Poor technology interface with the patient or environment
- Inadequate plan for implementing a new technology into practice, and
- Inadequate maintenance plan.

While technology has the potential to improve care, it is not without risks. Technology has been described as both part of the problem and part of the solution for safer health care, and some observers warned of the introduction of yet-to-be errors after the adoption of new technologies. Technology can be broadly defined to include clinical protocols and other "paper" based tools, but we will focus more on equipment and devices that are likely to encounter in delivering direct care to patients. The purpose is to provide a conceptual model for technologies that are likely to encounter and to delineate strategies for promoting their effective and safe use.

6. CONCLUSION

We have participated in several academic telemedicine projects during last three years. Although the potential of telemedicine was acknowledged in the beginning, the results of the majority of the projects were only of academic interest. The same trend can be found from the scientific literature. Although the rapid development of information and communication technology seemed to prepare an easy route for the telemedicine applications - still it was not an exception among the other developments. The development of everyday telemedicine applications required scientific studies, creation of awareness, and the development of the maturity of the underlying technologies, concepts and standards. The telemedicine application presented in this paper is successful, since all of the above mentioned requirements are met.

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