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A Study on Reliable Human Healthcare Self-monitoring Capability based Smart Body Situation Correlation Analysis

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Abstract

The convergence of wireless medical sensor networks (WMSNs) and RFID technology have elevated the advancement and sophistication of the self-monitoring capabilities of current u-Healthcare systems. Self-monitoring capability for u-Healthcare systems provides remote and timely real-time feedback of the health status of patients. This paper presents a pervasive architecture of a u-Healthcare system through the optimization of the advanced features of WMSNs and RFID technologies that performs continuous real-time monitoring of patient's health conditions, thus providing a reliable and efficient healthcare management system.

Keywords: *Healthcare, Wireless medical sensor networks, self-monitoring*

1. Introduction

The integration of Wireless medical sensor networks and RFID technology to u-Healthcare systems has brought the advancement and sophistication of its self-monitoring capabilities. The applications of self-monitoring among healthcare services have been rapidly increasing over the past years. Self-monitoring refers to the availability of wireless bio-sensors or medical instruments and equipment which are readily available for general public use to monitor and record personal bio-related data. The wireless bio-sensors can be wearable, implanted in the body or installed on the patient's homes, cars, workplaces, and other environment. Its healthcare applications and services could be digitally available through mobile device applications.

These wireless bio-sensors are capable of monitoring physical and mental conditions of patients in order to provide immediate care and implement interventions, and thus, improving patient's health. Examples of such bio-related information that can be self-monitored were the person's physiological conditions such as temperature, blood pressure, heart rate, breathing rate and volume, blood and urine chemical levels, glucose, activity levels and almost any other physiological characteristic that provides information in diagnosing health problems.

This paper aims to provide a pervasive architecture of a u-Healthcare system through the optimization of the advanced features of WMSNs and RFID technologies. The u-Healthcare system will be performing continuous real-time monitoring of patients through their physiological conditions to improve the reliability and efficiency of healthcare management systems. The current health status of patients can be timely determined and analyzed through outfitting patients with wireless, wearable vital sign sensors that can collect detailed real-time data.

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The rest of this paper is organized as follows: Section 2 discusses the related technologies which provide the enabling technologies for the future u-Healthcare systems; the framework for the Self-monitoring capability of a u-Healthcare system based on Wireless medical sensor networks and RFID technologies is outlined in Section 3; and the concluding remarks in Section 4.

2. Related Technologies

2.1 RFID Technologies

The wireless data transfer that uses electromagnetic fields called Radio-frequency identification or RFID aims to automatically identify and track tags that are attached to objects [9]. Basically, RFID technology has two major components: an RFID tag or label, and a reader. RFID tags contain digital information while an RFID reader transmits an encoded radio signal to interrogate the tag.

RFID tags or labels can either be passive or active. An active tag periodically transmits its ID signal while the passive tag is activated by the presence of an RFID reader [9]. It contains an integrated circuit that is used for storing and processing information, modulating and demodulating an RF (radio-frequency) signal, collecting DC power from the reader, and etc. It also contains an antenna that is used for receiving and transmitting the radio-frequency (RF) signal. An encoded signal is transmitted by the RFID reader in order to interrogate the RFID tag. As the tag receives the message, it then responds with its identification and other necessary information.

RFID have been widely used in many industries such as access managements, tracking of goods in supermarkets, tracking of persons and animals, toll collection in highways, passports, airport baggage, hospitals and healthcare, etc.

2.2 Wireless medical sensor networks

Wireless medical sensor network (WMSN) technology has been widely used as the enabling communication and implementation of remote monitoring and treatment of patients in u-Healthcare systems. The quality of u-Healthcare systems have been vastly improved and expanded through the integration of WMSNs across a wide range of situations.

A wireless medical sensor network (WMSN) in u-Healthcare is defined as spatially distributed autonomous devices using bio-sensors to monitor a physiological or environmental condition (such as temperature, sound, pressure, etc.) that incorporates a gateway that provides wireless connectivity to remotely distributed nodes of devices [5]. Wireless bio-sensors have been embedded in a wide range of medical and healthcare instruments or equipment for use at hospitals, healthcare centers, and homes. Such sensors (thermometers, blood pressure monitors, glucose monitors, electrocardiography (EKG), photoplethysmogram (PPG), electroencephalography (EEG), and various forms of imaging sensors) provide patients and their healthcare provider's insight into physiological and physical health states that are critical to the detection, diagnosis, treatment, and management of diseases or ailments.

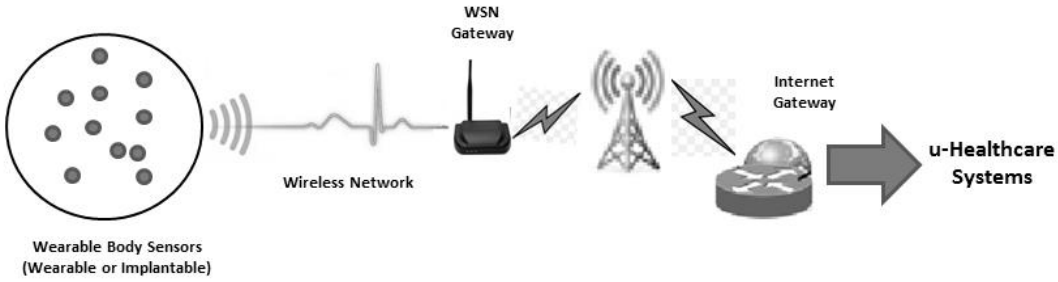

Figure 1. A WMSN Application in u-Healthcare

Patient monitoring and healthcare was made simple and effective through the implementation of WMSN in u-Healthcare systems as shown in Figure 1. Wireless networks are seemed to be more advantageous compared to wired networks as a communication technology for u-Healthcare thus simplifying the real-time and remote monitoring and treatment of patients.

2.3 Wireless Body Area Networks

Wireless body area networks (WBANs) or body area networks (BANs) are wireless networks of wearable computing devices [2, 3, 4]. It is designed to allow inexpensive but continuous healthcare monitoring with real-time updates of medical records through the Internet and logging vital parameters of patients suffering from chronic diseases such as diabetes, asthma and heart attacks. For example, (1) a BAN network in place on a patient can alert the hospital, even before they have a heart attack, through measuring changes in their vital signs; and (2) a BAN network on a diabetic patient could auto inject insulin through a pump, as soon as their insulin level declines [1].

Generally, WBAN is consists of vital sign monitoring sensors, motion detectors that is capable of identifying the location of the monitored individual and some form of communication that is used to transmit the vital signs and motion readings to medical staffs or u-Healthcare personnel [1]. Examples of wireless body area network components include the wearable physiological sensor devices such as RFID tags, SpO2 sensors, electrocardiogram (ECG) sensors and accelerometers that are worn by the patients.

The idea for WBAN area is relying on the feasibility of implanting comfortable and very small bio-sensors inside the human body but does not impair normal activities of the patient. The implanted bio-sensors in the human body will measure various physiological changes in order to monitor the patient's health status anytime and anywhere. The physiological information will be transmitted wirelessly to an external processing unit or user device. The user device will instantly transmit all physiological information in real-time to the doctors throughout the scope of the u-Healthcare system. If an emergency is detected, the physicians will immediately inform the patient through the computer system by sending appropriate messages or alarms on their respective user devices [2].

3. Self-Monitoring Capability Framework of U-Healthcare System based on WMSNs and RFID

The pervasive architecture of the self-monitoring capability of u-Healthcare system based on WMSN and RFID technologies is presented in this section. The system architecture, the block diagram of its components, as well as the process flow will be presented.

The design of the architecture of the WMSN based smart correlation control u-Healthcare system is depicted in Figure 2. The system consists of the *wireless bio-sensors*,

either wearable or implanted through the patient's body, *a monitoring user device*, capable of reading and pre-processing the different vital signs and bio-information received from the bio-sensors, and the *wireless technology communication*, such as RFID [6, 7, 8] or Bluetooth. This system is only a subsystem for the entire u-Healthcare system, which is a small, wearable lightweight module which contains these three basic components. The basic sensing functions that it can perform could be: temperature, pulse rate, SpO2, ECG, and other vital bio-information. The bio-sensors will be responsible for continuous measuring of this bio-information. For monitoring the user's location, an RFID tag will be utilized and RFID technology will be responsible for the transmission of the measured bio-signals to the user's device.

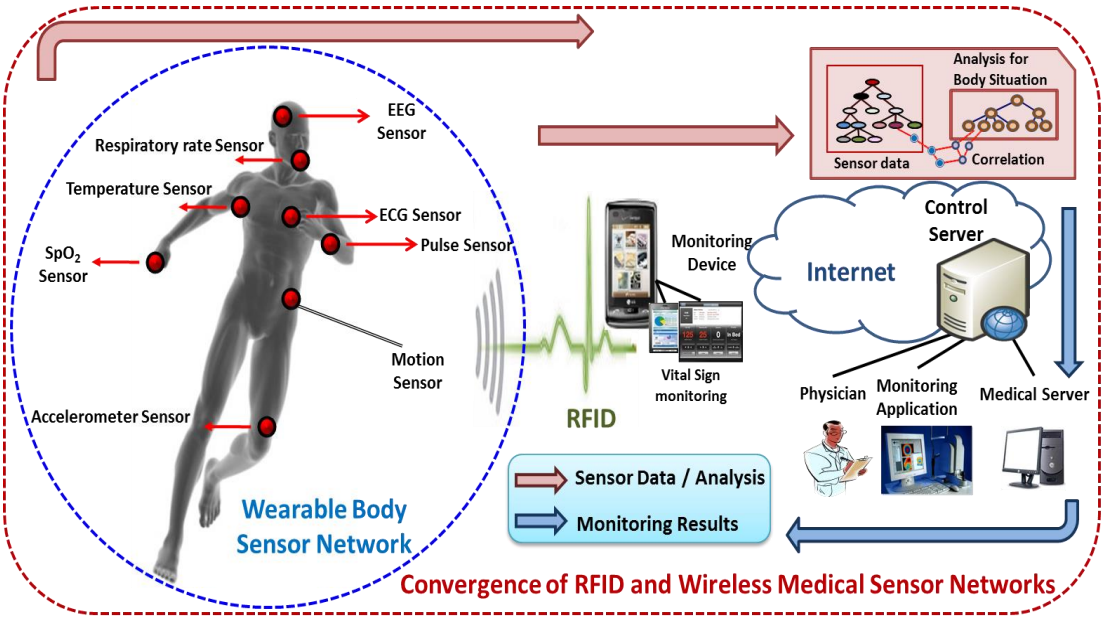

Figure 2. WMSN and RFID based smart correlation control u-Healthcare System

The pre-processed vital signs and bio-information are then delivered to the u-Healthcare system Medical applications for analysis and interpretations. To transmit the measured vital bio-information, the wearable sensor module works with the functions of the signal processing and controller blocks, and connects with the active RFID transponder as shown in Figure 3. Via a wireless network, the vital sign data are transmitted and received by an RFID reader connected to the monitoring user device and then transmitted to the u-Healthcare system medical applications module.

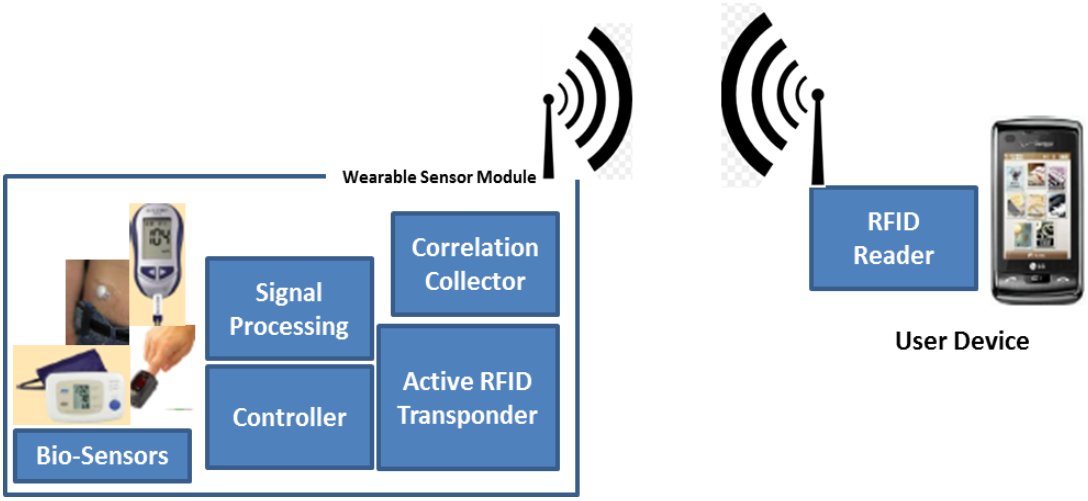

Figure 3. Block Diagram of Communication between the Monitoring User Device and the Wireless Sensors

A processing unit partially processes the bio-information (pre-processing) and saves them to a flash memory, then an active RFID tag identify and transmit them to the monitoring user's device which is responsible of sending this information to the u-Healthcare system medical applications module. The caregivers or healthcare personnel also carry a passive RFID to identify and locate them via specific base stations to reveal their locations. If a predefined condition is triggered, the system will send an alarm to alert the person on duty at the helpdesk of a medical center.

The designed u-Healthcare system performs medical routines by analyzing the user's bio-information gathered from the discussed module of bio-sensors attached to the user. The monitoring user's device extracts vital bio-information from the body sensors, and encapsulates the data into a fixed format for sending the vital data to the u-Healthcare system medical application module. The u-Healthcare system medical application module then conducts vital-information reasoning based on the received data, for suitable rules for the patient. The patient's current status and condition is matched with the patient history in the database. Based on the analysis, consultation and doctor will be chosen, and then the patient's information, diagnosis history, reasoning result, and the vital information will be sent to the doctor's device. The doctor will then diagnose and prescribe the patient accordingly and will provide these details through the user's device.

The u-Healthcare system provides continuous tracking and monitoring of physiological condition of the patients especially for the elderly people. A number of bio-sensor modules can exist and connected through Ad hoc network infrastructure and for simultaneous monitoring of a number of patients.

4. Conclusion

Based on the design architecture, remote and timely monitoring of patient's health status can be delivered through the self-monitoring capability of wireless medical sensor networks through the aid of RFID technologies for a u-Healthcare system. This paper has presented the integration of wireless medical sensor networks (WMSNs) and RFID technologies to u-Healthcare system that are capable of performing continuous real-time monitoring of patient's health conditions. The future improvement of this architecture will be realized through the practical field implementation of the u-Healthcare system.

Acknowledgments

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