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Implementation of Input Interface using General Data Transmission Methods for Digitalized BioSignal Data Management

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Abstract

The u-Healthcare is a new healthcare paradigm based on the Internet and ICT. Healthcare service using mobile devices includes sensor devices using measured biosignal data and home health network. The biosignal monitoring service is one of the monitoring services in ubiquitous healthcare. Methods of inputting, transferring, and managing biosignal data are so various that device interfaces need to be expanded. A transferred data format also needs a data transmission standard like Health Level 7. We implemented the sender/receiver interface using three devices including a PDA, a desktop computer, and a digital pen. Also the HL7-based biosignal message template and its database were designed. In the user input interface, patient/doctor's interfaces were developed separately and they enabled the user to review graphically the accumulated data. We adopted a digital pen having a powerful user-friendly input interface to develop the self-record manage application.

Keywords:

biosignal, Interface, Transmission, Database, Health Level 7, XML

Introduction

The healthcare services using mobile devices include various devices using measured biosignal data, home health network, electronic home appliances, and so on. The biosignal data management system usually monitors, analyzes and manages the biosignal data of wireless medical devices like blood pressure, pulse and ECG data, etc. In this system, some essential techniques are needed for the system functions of sending to the server wirelessly, storing, and managing the measured data. We tried to find how to input the wireless biosignal data and how to send them to the management system by an efficient data transfer method. First, to make the system construct easily and reuse the data, we referred to common data formats and transfer methods. Secondly, to full use of recent data input devices, we should expand input interfaces in ubiquitous environment. We considered several standards for EHR and applied Health Level 7(HL7) Version 3.0 to our application. We thought that HL7 was accepted medical informatics relatives as general standardized data transmission protocol. We had implemented the web-based patient monitoring system using HL7 Version 2.5 as a preliminary study in 2005. This research aimed the improvement of the previous study and it was new approach by adding user interface devices and applying the new version of standardized data transmission protocol.

Methods

The whole system are composed of 4 major parts: the client input interface of three devices, the server interface of sending/receiving data, and the user interface including a graphic view and a digital pen interface. First, we designed and implemented HL7 Message Sender/Receiver Interface. In the Message sending module, Blood pressure, pulse, respiration, temperature, SpO2 and general information of patient were input into the application program. The message receiving module was the server application of HL7 V3.0 message receiver. The server received a message from the client program and sent a HL7 V3.0 acknowledge message to the client program. The database was developed with Microsoft Windows 2003 Server, Visual C#, SQL Server 2000 and XML. It stored and managed the data in XML documents. The application program of home self-recording was implemented by a digital pen.

Results

1. **Design of HL7 V3.0 RIM-based Biosignal Database**

The Biosignal Database was designed using the RMIM (refined message information model) that was the restrained model of the HL7 RIM. The cMET schema for the measured data with texts, REPC_RM000130 (ObservationVitalSigns.xsd) was applied. It was able to easily transfer the received data into the server system. The database stored and managed them within XML format messages. We made basic messages of biosignal data with the general information of the patient, and composed the input XML template. The standard model was reflected on tables and attributes.

2. Design and implementation of message sender/ receiver interface system

When the data were input into sender devices, a desktop computer, a PDA phone, the sender interface system made HL7 3.0 XML files of them. Multiple files could be sent to the server simultaneously. The sender interface on desktop computer has the user interface of data input and sends the data into an each device and shows the converted XML files to the user. When the user enters his name and password for login on a PDA, the sender converts the written biosignal data to XML files and sends to the server database. Then the server sends an acknowledge message to the PDA application, and sends the data within XML files to the database.

If HL7 V3.0 XML files received from the sender interface are valid, the message receiver stores them to the integrated biosignal database in the server application. Each an acknowledge message (ACK) toward each valid HL7 message is sent to the sending interface. When an invalid message is received or when a communication error is occurred, the system sends the ACK message with a specific value of the error.

3. Web-based Biosignal Data Management

This application has a query function to review the accumulated biosignal data by data itself and graphics. After the program registers to the web server, users enter their name and password for login in a web site or a device interface and they can inquire or review their accumulated data by a web browser. The main function is that users can inquire their data sorted by time and data types in the table or graphic format.

The patient can review his accumulated data and view graphically by PDA phone application program. After the data inserted to the database, the patient can't edit them. After login, the doctor can monitor his patient's data anywhere.

4. Expanded input interface: digital-pen application

We designed the self-record manager program as a Windows application by C#. Self-records at home were composed with personal identification items, biosignal data input items, and a memo item that the patient could input any comment or any question to his doctor. The manager can recognize a user using the pen ID in the personal information register items, and the user doesn't need to enter its personal information each time. It makes the data store individually. The written pen data is converted to selected image types (jpg, png, pdf) and is stored. When a user selects the data, it is converted to a HL7 3.0 message XML file and is sent to the server.

We added and expanded another function to self-recorded papers in home, the program could autonomously input a date and time item, and a respiration input item. Figure 7 shows self-management record manager.

In the record format using a digital pen, about 80% character recognition was caused of presence of various handwriting patterns. So we added a correction function, and users could review and correct their written data. The push of the recognition button in the lower review window shows written data and users may correct and store them.

Discussion

We implemented input biosignal data interfaces on a desktop computer and a PDA phone. The user interface was different user screen according to the patient or the doctor. The measured biosignal data from each medical device was converted a standardized message format and sent to the data management system server wirelessly with the standardized transmission format.

The points of this study were the wireless biosignal data transmission and the application of standardized transmission protocol (HL7 V3.0). During the implementation of the applications, we faced with many problems again for using a general standardization protocol. Because items of HL7 message tags were so detailed that we were not easy to apply these items to the real message. The types of data are limited in this study. We have a plan to expand them and to expand applications of data transmission standards to other related studies. The database inquiry will also use the standardized message format. The future study of data transmission standards and technologies will be followed.

This study was one part of the Ubiquitous Biosignal Device Center Project in Korea. The project aims at developing everywhere-anytime healthcare system. By minimizing medical equipments and making the users (patients, doctors and nurses, etc) to carry them all the time. Our team is looking for the technology of standardizing and interfacing body information.

The biosignal data were continuously generated by mobile devices or wearable sensors. We started from pre-assumption that the data were already measured by sensors and the user wanted to enter them on his screen interface in this study. Finally all implementations were connected each other sub-study.

Conclusion

In ubiquitous environment, various user interfaces are needed to introduce biosignal data sending/receiving, test and expand. We implemented the user interface with a desktop computer, a PDA, and a digital pen using a standardized data transmission method. The standards are not easy to implement real situation but they will be a trend in healthcare delivery system. But they are so essential to

share the healthcare data and they can make software applications simplify. The technology-assisted application with a new device is convenient and potentially powerful complement to user-led management. The device easily to use can encourage users to self-manage their healthcare information.

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