Smart Home Healthcare Device based on Ubiquitous Communication

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Abstract: The aim of this research is to study and develop enabling technologies for home healthcare device with ubiquitous network. The motivation of this paper is to enable healthcare in home, to development the device for smart home health care. To achieve the aim, we must develop the prototype platform based on home gateways, distributed context user interface based on UPnP and support for information sharing with high speed power line communication and mobile infra-structures. And IPv6 is the base technology of this platform. In this paper, we concern that physical health, mental health and medical emergencies is all of home healthcare. With the smart device, we evaluate the connectivity, automatic information extraction and private data exchange and event driven message. The result of this paper is demonstration of smart device for ubiquitous communication in a healthcare application such as patient monitoring device and several information services. In conclusion, home healthcare will support more healthy and easy living for a human.

Keywords: smart device, healthcare, ubiquitous, mental care

I. INTRODUCTION

This paper is thing about the smart home healthcare which used ubiquitous network. It is paid ubiquitous computing and ubiquitous network with a base, and ubiquitous can do network for all kinds of things which stretched over a physics space at the same time that intellectual faculties anger gets a space done to listen to effort to get connection with new paradigm of computerization. That is, ubiquitous connects a person, a computer, things to a network and transmits each information in three dimensions and means the last step of computing letting you receive. Therefore, as for the healthcare of the ubiquitous times, it will be transformed into a new form. The reason is because monitoring service or a control program substitutes for the role in the form that the hospital and a doctor give a patient medical treatment. But development of the system that oneself measures own health condition in the interval that it cannot know to implement smart healthcare of true meaning and manages is essential. It stores the information that was measured after this sensor measures a human biological signal change, and perceiving in database through ubiquitous network.

There are "Things that think project" of MIT media lab, "Oxygen project" of MIT computer science lab., "Smart Personal Object Technology" of Microsoft and "The Realtime Operating System Nucleus" of tokyo univ. in recent study related to this. Also, there is "Smart Healthcare Monitoring Systems Project" of stanford univ., "Project Home Healthcare and Information Services" of LIU, "Home Automation and Healthcare" of MIT in study related to healthcare.

As for this study, an aging society was proceeded, and the try that tried to look up the solution in a point of time coming to the front became he gauge by the social problem that geriatric diseases was serious. Therefore, it is for a purpose of this paper uses the current network technology and computing technology, and solution to have done the problem.

II. SYSTEM STRUCTURE

This system can be expressed with physical structure and logical structure. Figure 1 is showing entire structure of this system. Physical structure is composed of device (Measurement Seat, Measurement Desk), WatchHome for a biological and behavior measurement and ubiquitous network (high-speed electric power line communication module, WiFi module), Smart Server, Mobile Agent, etc. Logical structure of this system is composed of physical care and mental care, emergency call. Physical care manages human physical health, and mental care manages mental health, and emergency call speaks a service call function of the time that an emergency situation generated.

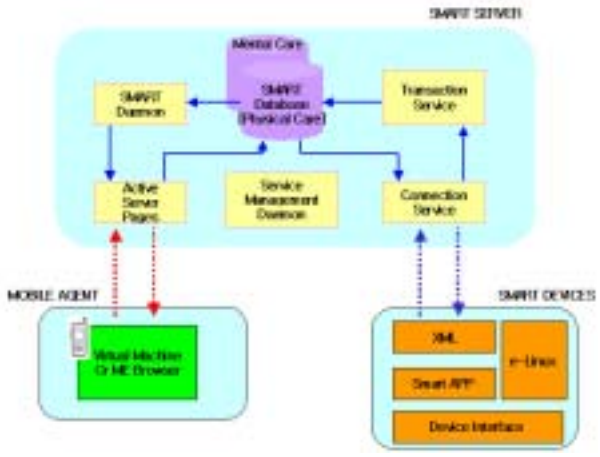

Fig. 1 Physical and Logical System Structure

1. Physical Structure

Physical Structure is composed of Measurement Seat, Measurement Desk, WatchHome, high-speed electric power line communication module, WiFi module), Smart Server, Mobile Agent.

Measurement seat measures a biological signal as the most basic device in smart healthcare and has a storage and a function transmitting. The largest characteristics of Measurement seat are nihility detention, things called nihility awareness biological signal measurement technology. This device is installed in a toilet and this device uses an independent electrode and can measure an electrocardiogram, a pulse, heart rate, body temperature, fat. It can contacts with a human body, and this electrode measures the biological signal in the state that a user cannot recognize when a user uses a toilet directly. However, this device compares with the existing system, and an a little low disadvantage is with measurement precision. But It has a very convenient merit in the user side. Blood pressure (NIBP) or the Glucose, weight can measure additional information by a need of a user if it uses Measurement Desk additionally. Periodic vital sign measured by a user is transmitted to Smart Server through a network after it was stored in memory. We used ICD-100 of Digital ComDoctor for integrated signal measurement. A measurement device and Temp sensor, ECG Lead, fat Lead are included in ICD-100. And extra made adhesion-type Electrode connects it to ICD-100 for measurement. Also, Cuff for blood pressure measurement and blood tester for glucose are included, too. A basic function of ICD-100 is a measure ECG(Electrocardiogram) by 1 1ead type, glucose by the electro-chemical method, NIBP(Non-Invasive Blood Pressure) by oscillo-metric method, temperature of body, heart rate and body Impedance. Figure 2 is showing a connector section of ICD-100.

Fig. 2 ICD-100

Fig. 3 WacthHome

Measurement Seat and Measurement Desk measure mainly biological information, but WatchHome has a function to collect a human behavior or environmental information. WatchHome has a high-quality images CCD device and observes human action patterns. And this has Audio codec and observes environmental changes. The existing healthcare devices are measuring mainly physical health, but environment related to human mental health or demand of information about a behavior pattern is increasing. Therefore, we used the Watch Home which was device of a new form in order to solve this problem. This device has 300,000pixel CCD Camera,SAA7113 Interface, ARM720T Core of Sharp. This is doing a basic image processing in embedded Linux environment. Also, this calculates behavior pattern analysis algorithm and JPEG compression and graphic overlay for mixed reality. Besides, with the Voice codec which used DSP CT8022A, and the noise or a voice perceives an environmental change. Figure 3 is showing actual prototype of Watch Home.

This image information and data can use the physician in charge through own mobile phone through Mobile Agent directly. We used BREW Platform equipped CDMA of Qualcomm with and implemented transmission of an actual image. An BREW emulator image capture scene is looking in figure 4.

Fig. 4 Mobile Agent

The thing that is indispensable in order to transmit a measured biological signal from Measurement seat to Smart Server is ubiquitous network. The basic difference that distinguishes general network from ubiquitous network is Universal Plug and Play and Ipv6, and XML this. There is two type in network device composing Ubiquitous network. A wireless network and a wired network are them.

First of all a device composing wired network is a high-speed electric power line communication module, and, as for this, data transmission of the largest 14 Mbps is possible. The existing electric power line communication method is a OOK and frequency modulation method by center frequency, but it was the low-speed communication. But it is developed high-speed communication by an Orthogonal Frequency Division Multiplexing method. But deregulation must be performed. Transparently connects 10BaseT ethernet devices to powerline network, HomePlug 1.0 compliant, Large bridge tables with advanced ageing allow for virtually unlimited nodes is characteristics of high-speed electric power line communication. Device using in this system used INT51X of Intellon as main signal processor and used 10Bit AGC, 3-Status Buffer, Power

Amp, AC Coupling as Analog Front-End circuit, PHY chip for connection with 10BaseT. A module for INT51-based high-speed communication looks in figure 5, and the block diagram is shown in figure 6.

Fig. 5 PLC module

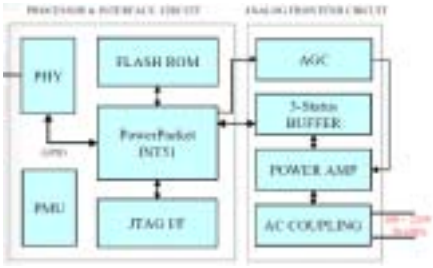

Fig. 6 Block diagram of PLC module

International standards IEEE802.11x to call WiFi is well-known for a wireless accessed standard recently. It is used as a notebook or a network device of PDA very much at present. The largest merit of WiFi is a mutual authentication way of a wireless subscriber, legal user authentication. Also, it is what was able to realize comparatively simply high-speed access at low cost. We used Buffalo LAN Card as PDA Network Interface for Client Service implementation in this paper. And we used CE.NET 4.2 to Client environment. Because these two device having a different connection method can keep compatibility by OSI 7 Layer completely, application and a change are easy as necessary. Figure 7 is showing basic screen configuration of PDA..

Fig. 7 screen configuration of CE.NET

So far we explained Ubiquitous network in a hardware viewpoint. However, UpnP, Ipv6 and information technology as XML are necessary more in order to become the ubiquitous network which is not general network like the above-mentioned thing.

First of all UpnP technology gives device of other kind to a mutual-compatible connectivity and in the networks and does these in order to become integrated control. There is OSGi with technology related to this, but integration has the disadvantage that was not performed in the networks. Element technology to be key in UpnP is this such as communication between server and client, integrated management of control point, real-time scheduling along user setting, compatible between OSGi and UpnP, integrated service in independent device network.

We are aware of the address that was based on the existing IPv4 in order to connect a great number of device to ubiquitous network having been short. Technology solving these problems is just IPv6. An address system of IPv4 is 32bit, but can easily connect a great number of devices to network because an address system of IPv6 is made of total 128bit.

The technology that maximization gets mutual communication and use of information done by with a base with hardware technology and communication infrastructure as IPV6, UPnP is XML(eXtensible Markup Language). The case of popularized HTML was faithful to an expression of a network and information, but has a very vulnerable disadvantage to treats meaning of actual information. Too various multimedia type and a structured information expression are hard. A case of SGML is a form to be suitable for a storage and processing of information, but configuration and grammar are too difficult, and implementation has a hard disadvantage. However, as for the XML, we let you integrate these two language and store information with a standardized form and increase a use rate and have the aim of massification through a web environment offer. XML has a form to be suitable for a storage and processing in addition to delivery and an expression of information again.

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  </user>

</smartdb>
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2. Logical Structure

Logical structure of this system is composed of physical care, mental care and emergency call. The structure is that physical care for the human physical health, the mental care for the mental health, emergency call for service call of the time that an emergency situation generated.

It is physical care has the vital sign which measured in the above-mentioned Measurement Seat or Measurement Desk, and to confirm a basic health condition. There are a blood pressure, a pulse, an electrocardiogram, temperature, fat and the weight, glucose in human basic vital sign. This vital sign is measured through a measuring instrument, and it is transmitted to Smart server regularly. A health condition is dealt with statistically by Database and Knowledge base, and these data are managed by the physician in charge. This information just informs a dangerous condition by Threshold numerical value to have been set up individually. Also, correlation between each other has

basic vital sign. It is for it to be checked an entire health condition according to this correlation. Figure 8 shows actual measurement value of vital sign, and Figure 9 is showing standard deviation.

Fig. 8 measured value of vital sign

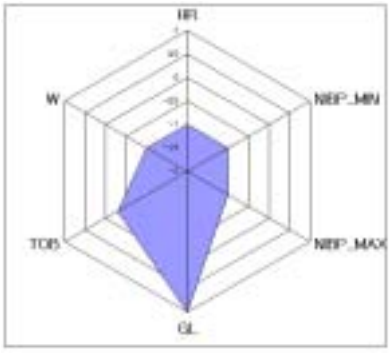

Fig. 9 standard deviation of vital sign

An interest about mental health is rising in addition to human physical health recently. However, as for this mental health, direct measurement is not easy. Therefore, indirect measurement is performed by an environmental measurement method or a behavior pattern generally. We used a CCD camera in this study and applied a quantity of human action and behavior pattern analysis technology. And we collected speech and executed feelings analysis. And monitoring can do a patient a doctor directly. This analysis has a behavior pattern in action range and assumes human warning concentration state, probability a little information about anxiety or depression.

Also, we can know fault information in sleep if we analyze these data by a time zone. And we can apply emotional analysis technology along a color change or brightness of illumination, too. It is emotional analysis technology divides an input sound change by an individual element through spectrum analysis by a sound analysis, and to forecast a psychology by emotional engineering. Also, the patient whom a psychological treatment needs can listen the sound according to a psychology. Besides, we provide a monitoring way by the physician in charge directly if a continuous watch or control is requested if indirect decision is hard. In this case, we use Mixed realty, and overlay does graphics in an actual image in order to protect personal private life. Figure 10 shows a behavior change by an image processing, and figure 11 shows change rate in a time zone.

Figure 12 shows emotion recognition algorithm by speech, and figure 13 shows the recognition results expressed with a graph.

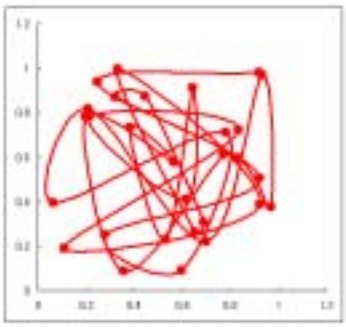

Fig. 10 behavior graph

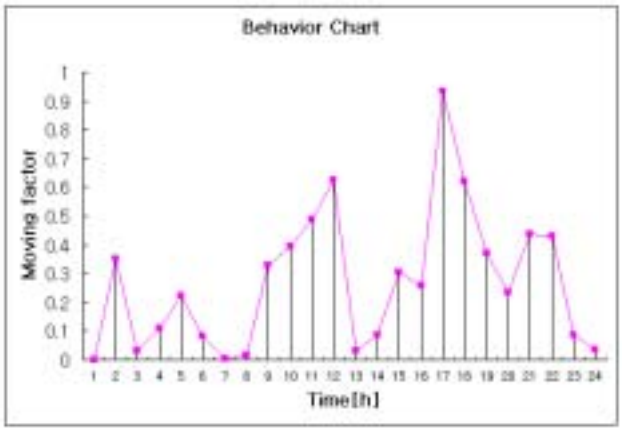

Fig. 11 change rate in a time zone

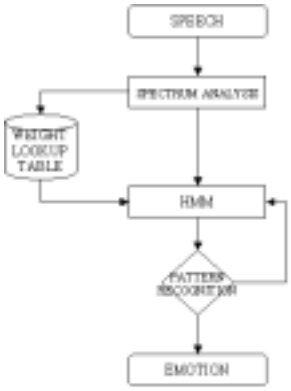

Fig. 12 emotional recognition

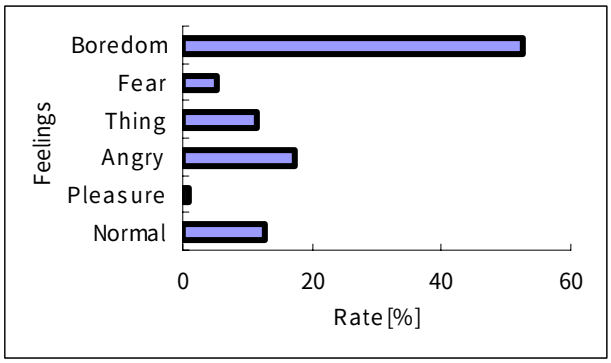

Fig. 13 recognition result for emotion

Emergency call is the call function that the risk that it is fatal by physical and mental health prepared for the case that

occurred. There is direct and indirect call. If the fail occurred in vital sign or mental status, indirect call rises, and call is the case that a user requests by a need directly. If Emergency call occurs, information becomes transmission with shot message service to the physician in charge and a family. by Mobile Agent and can remove a risk element immediately

III. CONCLUSION

We proposed the smart home healthcare which used ubiquitous network in this paper. It is to have got more development with one phase of Healthcare with a base with ubiquitous computing and ubiquitous network to be able to be called the core of IT. Key elements of this study are nihility detention, nihility awareness measurement, mental health analysis, ubiquitous network. If biosensor technology develops more, and this measurement technology will develop more. Also, it is obvious that a behavior pattern, measurement of environment, analysis technology for mental care development too more. Above all, it is the most important that integrates on ubiquitous network.

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