

A Design of the u-Health Monitoring System using a Nintendo DS Game Machine

SangJoon Lee*, Jinkwon Kim*, Jungkuk Kim** and MyoungHo Lee*
Yonsei University*, Myoungji University**

Abstract—in this paper, we used the hand held type a Nintendo DS Game Machine for consisting of a u-Health Monitoring system. This system is consists of four parts. Bio-signal acquire device is the first. The Second is a wireless sensor network device. The third is a wireless base-station for connecting internet network. Displaying units are the last part which were a personal computer and a Nintendo DS game machine. The bio-signal measurement device among the four parts the u-health monitoring system can acquire 7-channels data which have 3-channels ECG(Electrocardiogram), 3-axis accelerometer and tilting sensor data. Acquired data connect up the internet network throughout the wireless sensor network and a base-station. In the experiment, we concurrently display the bio-signals on to a monitor of personal computer and LCD of a Nintendo DS using wireless internet protocol and those monitoring devices placed off to the one side an office building. The result of the experiment, this proposed system effectively can transmit patient's bio-signal data as a long time and a long distance. This suggestion of the u-health monitoring system need to operate in the ambulance, general hospitals and geriatric institutions as a u-health monitoring device.

I. Introduction

The variety u-Health system and device have been developed cause by the aging society, increasing of cardiovascular and relating disease. The diversity type of u-health devices can connect up the USN(Ubiquitous Sensor Network). Especially, ECG(Electrocardiogram)[1] which bio-signal need to watch for 24-hours for a cardiac patient throughout the USN. These bio-signals are important not only measurement device for continuously acquire bio-signal but also a method of measurement concept. Figure 1 is shown that typical of u-health monitoring system's concept. Depending on the Figure 1 which is consists of three parts. Measuring bio-signal, transmit the acquired data on to the wireless network system and display data to the appropriate device. In this paper, for consisting the u-Health monitoring system, measurement device transmit data such as patient ECG, 3-

axis accelerometer sensing and tilting data throughout the wireless sensor network which wireless area sector where is restricted[2]. The base-station is converting the data to appropriate TCP-IP (Transmit Control Protocol / Internet Protocol) data to access the internet network. Nintendo DS game machine and personal computer received and displayed on to their own screens with the acquired data throughout the internet network. It is possible to real time display each devices. Especially, the Nintendo DS use wireless internet access with WI-FI(Wireless-Fidelity) on the contrary the personal computer connect up the internet with wired internet network.

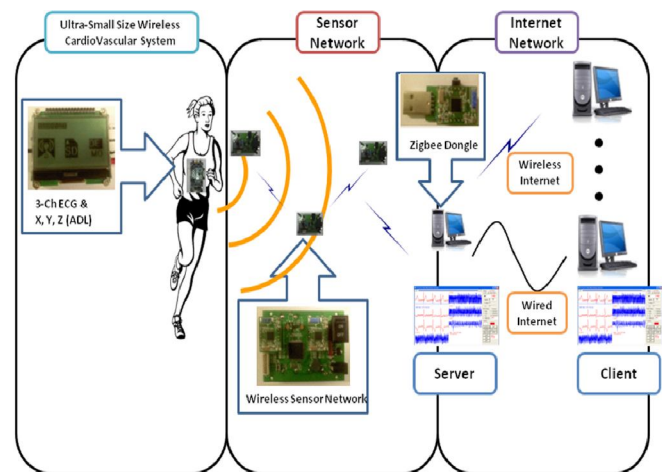


Figure 1. Typical a u-Health Monitoring System

II. Nintendo DS Game Machine

Usually, u-Health monitoring system typically uses personal computer, PDA and Cellular phone but which may occur some problems such as high price for buying the monitoring device, additional service fee for transmitting and receiving data and limitation of movement. So, these problems are disturbance factor of promoting u-Health care service. In this paper, we proposed that to use the Nintendo DS Game machine throughout wireless internet network on the u-Health care monitoring device for solving these problems. NINTENDO, the world's largest game machine maker, also sold over 100 million the Nintendo DS game machine after that putting on sale 2004, 3[3]. So that, if we use this gadget in u-Health care monitoring system, we will expect good effect about the high user accessibility also the device is just \$150 US dollar which is very cheaper comparing other device such as a personal computer(over \$500 USD), a PDA(over \$500 USD) and a Cellular Phone(over \$200 USD). Nintendo DS also can access wireless internet network with the WIFI function. In this

*SangJoon. Lee Author is with Department of Electrical and Electronic Engineering Yonsei University, 134 Sinchon-dong, Seodaemun-gu, Seoul, Korea(first author to provide phone: +82-10-2269-8558; e-mail:sj.lee@yonsei.ac.kr)

Jinkwon Kim Author is with Department of Electrical and Electronic Engineering Yonsei University, 134 Sinchon-dong, Seodaemun-gu, Seoul, Korea(e-mail:JinKwon-malbox@yonsei.ac.kr)

Jungkuk Kim Author is with Department of Electrical and Electronic Engineering Myoungji University, Yong-In KoungKi, Korea (e-mail:jk.kim@mju.ac.kr)

MoungHo. Lee Author is with Department of Electrical and Electronic Engineering, Yonsei University, 134 Sinchon-dong, Seodaemun-gu, Seoul, Korea (corresponding author to provide phone: +82-2-2123-4946; fax: +82-2-312-2770; e-mail:mhlee@yonsei.ac.kr)

means, we don't have pay additional payment to use special wireless network for receive or transmit the bio-signal data. We convince that the u-Health service will promote when we use Nintendo DS game system for continuous patient monitoring device. As shown that figure 2 is internal structure of the Nintendo DS game machine and detail specification as below.

Nintendo NDS System Specification [4]:

- CPU: 67Mhz ARM9 and 33Mhz ARM7
- Media: GBA cartridge & Nintendo DS Game Cards
- System storage : 4Mbyte RAM
- Connectivity : Wi-Fi and LAN
 - Speed: 1Mbps or 2Mbps
 - Supports wireless IEEE 802.11

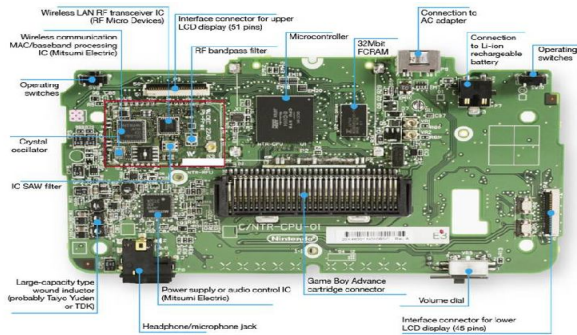


Fig 1 Key Circuitry Clumped on One Side. The photo is close to the actual size – 141 x 78mm (longest area). The wireless module and microcontroller were covered by a metal shielding plate.

Figure 2. Internal structure of Nintendo DS Game System

III. Ultra-Small Size Wireless Cardiovascular System

We designed bio-signal measurement device hardware that ultra small size and low power consumer which for using optimum hand held type device and a long term measurement bio-signal monitoring. As shown that Figure 3 is the block diagram of a wireless cardiovascular system. The device size is too small to move another place to place which size is about 5.5cm x5cm. Also, it has low power consume about 22mA/H can acquire and transmit the bio-signal data with non-recharging during for 24-hours when it use 3.7V, 500mA, Li-Ion Battery.

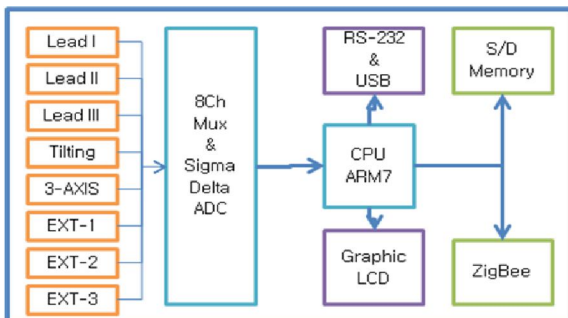


Figure 3 Block diagram of wireless cardiovascular system

It designed ECG measurement hardware is use to Einthoven's Triangle method[5] and insert the 0.01Hz High Pass Filter of the analog terminal block. For falling detecting of patient, it inserts the 3-axis accelerometer and tilting sensor circuit[6]. Each sampled data acquired with 500Hz sampling and 16bit data condition when it convert analog signal to the digital data. At the result, the device acquire 7-channels digitized data which is consist of ECG Lead I, II, III, X, Y, Z and Tilting. As shown that Figure 4 is data transmit protocol when it send acquired whole data throughout the wireless Zigbee module [7]. The device has two operation options one is wireless transmitting mode and the other is the data saving to the Digital Media. For reduce power consume, it can store digital data of seven channels to the SD Memory Card when it doesn't connect wireless sensor network. Lastly, the final data changed by transmitting protocol algorithm and compressing data as a real time compress algorithm [8]. As shown that Figure 5 is actual operation of proposed ultra small size and low power consumer wireless cardiovascular system.

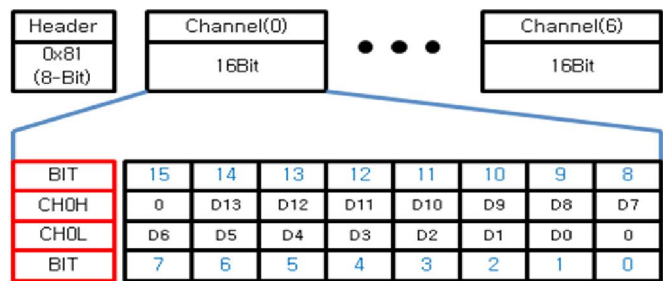


Figure 4 Data transmit protocol

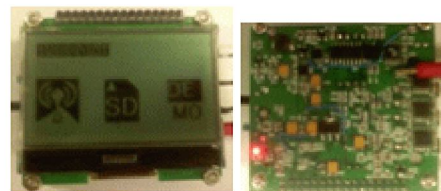


Figure 5 Ultra small size and Low power consumer wireless cardiovascular system

IV. Sensor Network

Commonly, the communication distance is about 10-meter of the Zigbee module is shorter than the Bluetooth module. Consequently, the Zigbee module must overcome restrict of communication distance for consisting the wireless sensor network. The solutions are the Wireless Local Area Network (WLAN) and Wireless personal Area Network (WPAN) [9]. As shown that Figure 6, typical of wireless sensor network and need base station to convert TCP-IP protocol data with connect internet network. As shown that Figure 7 is the wireless base station block diagram. The

display unit connect up the internet Hub with own device's IP using TCP-IP protocol. The terminal device can access with wireless WI-FI module or wired internet line. As shown that Figure 8, we design the actual wireless base station. The base station can connect with Computer, PDA, Nintendo DS and so on.

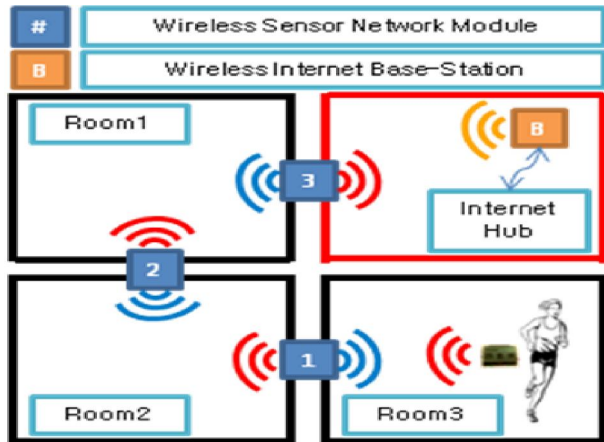


Figure 6 Typical of wireless sensor network concept

V. Wireless base-Station

For the experiment, we programmed personal computer display program with a C language base tool which is Lab/Windows CVI 8.0(National Instrument Company, USA). Using the PALIB[11], we can program Nintendo DS application program on the PC environment. Also, we add the function with encryption and compression algorithm for protecting personal bio-signal information and efficiency of the communication [8].

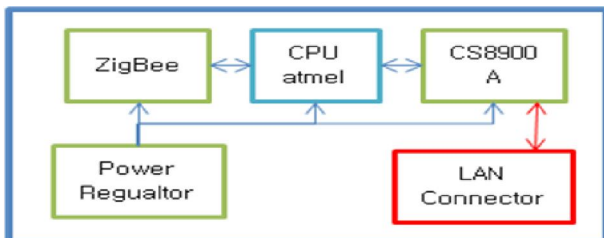


Figure 7 Block diagram of wireless base station

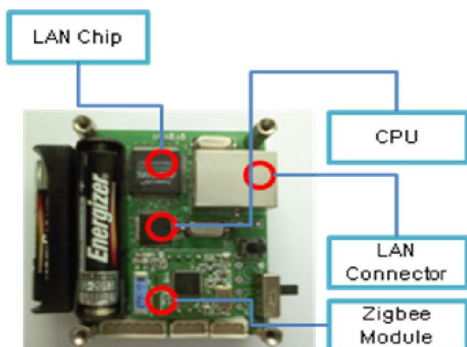


Figure 8 Wireless base stations

VI. EXPERIMENT AND DISCUSSION

In the experiment method, as shown Figure 9, we measured bio-signal data using the wireless cardiovascular system which connect 4-lead electrode to the patient's body during for 10 minute. Measured data are 3-Channel ECG data, X, Y, Z, Tilting Data which are compressing and encrypting with a real time processing algorithm and send the acquired data to wireless sensor network module and wireless base station. Corresponding IP is separating two office buildings. One office building watched the acquired data with personal computer using the wired internet connecting and the other office building watch the patient's ECG data with the Nintendo DS game machine using WIFI wireless internet connecting. Also, we verify that two devices viewing are the same display result. Figure 10 is actual measurement experiment picture with wireless cardiovascular system and as shown that Figure 11, received data display on to PC Monitor by wired internet connecting. Figure 12 is shown that displaying of patient's ECG signal on to Nintendo DS game machine's LCD with received by WI-FI wireless internet connecting.

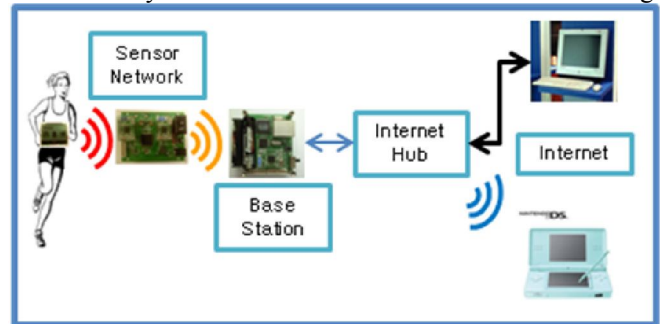


Figure 9 Concept of experiment method

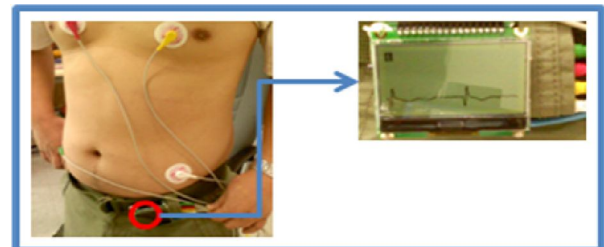


Figure 10 Actual experiment picture

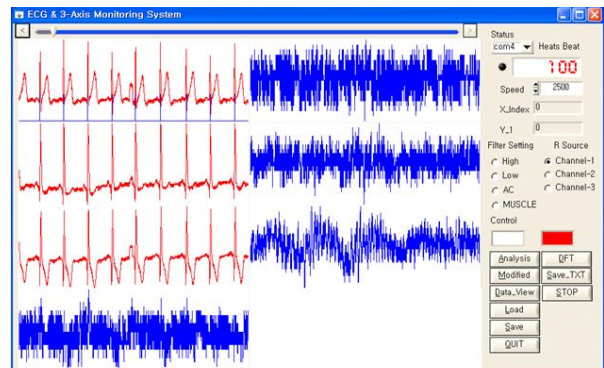


Figure 11 Computer display program



Figure 12 Bio-signal displays on to Nintendo DS LCD

VII. CONCLUSION

In this paper, we develop u-Health Monitoring device and display the measured data on to Nintendo DS game machine. To Overcome wireless communication distance restrict, consist with the sensor network system when it transmit the acquired bio-signal data. Especially, this device can detect the patient's hearts problem, falling detection and patient location in the restrict area with a real time analyzing and processing if we adapt to appropriate algorithm [10]. Acquired data can send some wanted place where are in the ambulance, a general hospital and a geriatric institutions. We convince that this business model and devices successfully perform as a u-Health monitoring system.

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