1. INTRODUCTION

Recently, patients with chronic diseases such as cancer, diabetes, hypertension or cardiovascular disease are increasing due to westernized eating habits and aging of population. Healthcare cost is increasing due to the increase in the number of patient. This causes the international competitiveness of medical and health services to be improved[1].

Providing patients with convenient health facilities at a lower cost has always been a great challenge for health service providers. Moreover, the fast changing lifestyle of the modern world and the problem of aging society pose an urgent need to modernize such facilities. This involves devising cheaper and smarter ways of providing healthcare to people suffering from age related disease.

The u-healthcare(ubiquitous healthcare) technology is a combination of information communication with medical service to allow a patient to take care of himself or to allow a caregiver to take care of the patient at anywhere and anytime. To provide much freedom to patients in the u-healthcare service environment, it is important to integrate wireless communication technology for modern healthcare systems[2]. Several biomedical meters or sensors such as glucose meter, pulse oximeter, ECG sensor are used for the u-healthcare system. There are mainly two communication methods to provide freedom to patients who take biomedical sensor modules on the body. Wireless network and wireless sensor network(WSN) have been used for the u-healthcare services[3]. Until now Bluetooth or ZigBee communication module is used for the data transfer from sensor nodes attached on the patient’s body to the gateway or cellular phone. The personal health data gathered at the gateway is sent to the server computer through the internet. ZigBee is an alliance, without sprit of lucre, of more than 100 companies, where most of them are semiconductor manufacturers. ZigBee and IEEE 802.15.4 are standards-based protocols that provide the network infrastructure required for WSN applications. The 802.15.4 defines the physical and MAC(Media Access Control) layers, and ZigBee defines the network and application layers. This technology is focused on creating low-rate personal area networks(LR-WPAN). In wireless sensor network, the biomedical data is transferred by multi-hop communication via several wireless sensor nodes. It is presented as a very economical solution for WSN. ZigBee products work in a...
band of frequencies that includes 2.4 GHz, and 868 MHz in Europe or 915 MHz in North America. It consumes very low energy and battery can be kept for several years. On the contrary, their typical coverage is around 50 m, although this value could increase, depending on the environment[4].

However, Bluetooth is open specification for wireless networks based on radiofrequency that operates in the industrial scientific medical frequency band(2 GHz, 4 GHz) forming wireless personal area networks(WPANs). Bluetooth controls its interference and susceptibility to interference by using spectrum modulation. Bluetooth was formalized in the IEEE 802.15.1 standard. In Bluetooth, 79 different channels can coexist, although there are no defined routing capacities for multi-hop wireless sensor network. This technology achieves 100 m of coverage radius, although it consumes higher energy than ZigBee communication and battery can last for several days. The one of advantage of Bluetooth technology over ZigBee in healthcare is smart phone compatibility. Recently all the smart phones have a built-in Bluetooth chip[5]. Therefore, every sensor with Bluetooth communication module attached on the body of a patient can transmit the biomedical data to the mobile phone[6].

This paper presents a mobile healthcare system for the continuous monitoring of patients under their natural physiological states or elderly persons with chronic diseases. Our system is designed specifically for the patients who wear wearable shirts with imbedded ECG sensor with a focus on convenience in daily life of wearer. A small size ECG sensor with Bluetooth communication module is designed and fabricated. The ECG signal evaluation software in Android based smart phone is developed for the health check and the ECG signal variation is tested according to the activities of the wearer such as walking, climbing stairs, stand up and sit down, and so on.

2. SYSTEM CONFIGURATION

A mobile healthcare(m-healthcare) system which monitors health status and daily life activities of patient or elderly by using wearable ECG sensor alone attached on the body of the wearer is proposed. The m-healthcare allows seamless data analysis and diagnosis. Until now two kinds of mobile healthcare system have been developed. The first one sends the health data from the cellular phone to the internet connected to the server PC. Then, a doctor or caregiver checks the health status of the patient or elderly through internet. The mobile healthcare system is connected continuously to the internet and has to pay expensive data fee. The second one monitors the health status of cellular phone holder by the evaluation and monitoring software of the biomedical signal in the cellular phone. Our mobile healthcare system is the second one and for the patient, elderly or normal person itself who has cellular phone, smart phone or tablet PC such as Galaxytab(Samsung Electronics Co. Ltd., Korea) and ipad(Apple Inc., USA). Fig. 1 shows the proposed architecture of m-healthcare system. The proposed system consists of hardware and software. Hardware consists of ECG module, MCU, smart monitoring device and software consists of application based on Android OS.

2.1 Hardware

Fig. 2 shows the hardware part of the proposed M-healthcare system. Hardware consists of sensor part(ECG module), data process part(MCU, ATmega128), and output part(smart device). ECG sensor is designed to be located at central part of chest in wearable shirts to increase the convenience of ECG measurement in daily life of the wearer.

ECG module which can measure ECG signal consists of LPF(Low Pass Filter) circuit, HPF(High Pass Filter) circuit and amplifier circuit. This circuit measures micro current signal from heart. The MCU(8 bits microprocessor of 16 MHz frequency) is responsible for data processing using UART, ADC, Timer/Count functions. The best methods of communication are Bluetooth that can communicate well with smart device. Nowadays most of mobile device such as cellular phone, smart phone, tablet PC has Bluetooth receiver inside. Android application is designed to monitor ECG wave like signal on the monitor.