Design of Bodyfat Measurement System based on the Android Platform

Woong-Sik Kim

[1] Intergate IT School, Colledge of interdiscip.inary & Creative Studies
Konyang University
{wskim@konyang.ac.kr}

Abstract. As the recent advanced in BIO signal measurement technology, our computing platform is rapidly shifting from desktop PC to Embedded System. Therefore, In this paper introduces an implementation of the same precision as a hospital body fat system on the Android Platform. The most important fact of the hospital system is connectivity among the PC such as separate means of communication, we can eliminate the separate means of communication through the Porting Embedded System on Android Platform that can be receive body fat signal directly. We also implementation body fat Apple on Android Platform that can analyze and show the data result directly.

Keywords: Bodyfat, BIO Signal, Android, u-Healthcare, Measurement System

1 Introduction

Body fat is the fat a human body contains. It is the energy storage which stores surplus calories after the body uses up calorie intake. When the body needs it, it decomposes into energy.

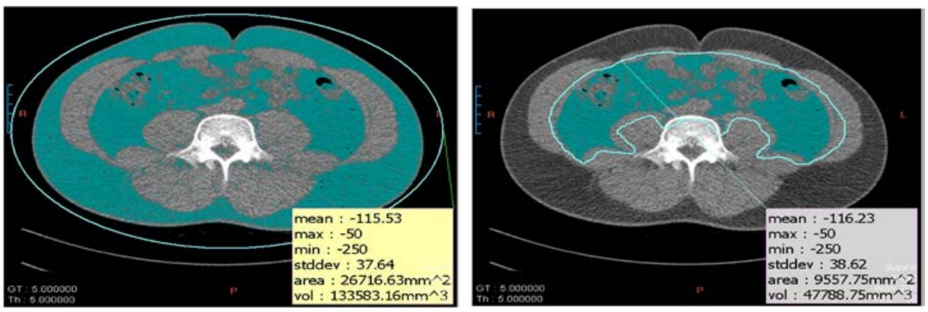

Fig. 1. Abdomen of the belly of the CT images using the pixel based method in the entire fat distribution (A) and the fat distribution of visceral(B).

The body fat percentage is the percentage of the body fat to the body weight. For a man, it is 10-20%, and for a woman 18-28%.[1]

The percentages of visceral fat and subcutaneous fat are different individually by the degree of obesity and the amount of exercise.

When people become adult with obesity, normally the abdominal fat percentage becomes higher due to an excessive visceral fat. This abdominal obesity is the cause of adult diseases such as high blood pressure, cardiovascular disorder and diabetes.

It is because the subcutaneous fat is accumulated far from the center of the human body anatomically. Yet, even though the oxygen transfers through microvessles, the visceral fat relatively connects with large blood vessels so that it is highly active.

2 Main discussion

To measure the body fat, let micro alternating current with 50 kHz and 100 μA flow into the body through two input electrode plates.[2]

And the resistance composition of the body is calculated by measuring the voltage between two electrodes.

Besides this, the information of height, gender, weight and age of a person is needed. The amount of a body fat is calculated by subtracting FFM(Fat Free Mass) from the weight of the user. The three existing calculating methods to measure a fat free mass are shown in equations 1. Its unit is Kg.

$$FFM_{PAT} = 4.033+G_{PAT}\times(0.734\times(H^2/R)+0.096\times X)+0.116\times A+0.878\times G\ . \tag{1a}$$

$$FFM_{HYU} = 0.0005+H^2-G_{HYU}\times Z+0.392\times W-0.0684\times A-5.1841\times G+24.678\ . \tag{1b}$$

$$FFM_{HOOT} = 0.61\times G_{HOOT}\times(H^2/R)+0.25\times W+1.31 \tag{1c}$$

Here, H(cm) denotes the height, R(Ω) the Resistance, X(Ω) the Reactance, A the Age, Z(Ω) the Impedance, W the Weight. G denotes Gender and its value is set as 1 for male and 0 for female.

G_{PAT}, G_{HYU}, G_{HOOT} are constants which values are related to the values of Impedance measured from the body of the user. All these values are set as 1 in existing equations. In existing methods, the body fat was measured by attaching two hands and two feet closely on electrodes.

As a voltage differential is measured by attaching two left and right fingers in the implementing system, it is hard to apply the existing equation as it is. Therefore, in order to revise this, the impedance and its related constants are used as tuning elements.

Fat Mass(FM) is described as in the equation 2.

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[1] Doosan World Encyclopedia EnCyber

[2] Evaluate a body water by the Bioelectrical Impedance method. Koryeo University Sport Science Research Center, a collection of treatises, volume 9, pp 215~227

$$FM = W - FFM(Kg) \tag{2}$$

Body Fat(%BF) can be calculated as in the equation 3.

$$\%BF = (FM/W) \times 100(\%) \tag{3}$$

And Body Mass Index(BMI) is calculated as in the equation 4.

$$BMI = (W/H^2)\ (Kg/m^2) \tag{4}$$

The amount of the body water which measures the water in a body can be calculated as in the equation 5.

$$TBW = 0.59 \times G_{TBW} \times (H^2/R) + 0.065 \times W + 1.04(Kg) \tag{5}$$

Based on measured body fat, daily calory consumption can be calculated by substituting user's walking steps into the equation. The equation 6 shows daily calory consumption(C).

$$C = 1.11 \times (K_a \times W + K_b \times W^n) \tag{6}$$

K_a denotes a living activity index, W a weight, K_b a basal energy metabolic rate, and n=0.424* constant.

The measuring equipment for the body fat currently made for a commercial use measures the body fat in various parts of the body by attaching electrodes on legs and arms or by grabbing electrodes attached on handles by two hands.

In the implemented system, the body fat can be measured by attaching electrodes on four fingers. Therefore, based on the results from various clinical demonstrations, tuning coefficients of the equation is necessary.

From the result of clinical demonstrations, the heart rate result is accurate, but there is much error in the body fat measurement depending on how a user grabs the electrodes with hands.

In case when he grabs electrodes properly, there is about 10% error compared to the product for common use.

3 Test and Result

3.1 How to measure the body fat

The above figure shows a circuit diagram for the measurement of the body fat. In the first component of the circuit diagram, there is a part which causes a frequency of 100 uA, 50 KHz entering into the body.

Due to a delicate difference in PCB pattern, in order to overcome the some voltage differential in each board, namely for calibration, 5 KΩ adjustable resistance is provided.

A signal occurred in the main circuit enters into the body. And after the signal passes through the body, it comes out by both inverting amplifier and non inverting amplifier. The output signal is analyzed by ADC of MCU and MCU to measure the degree of the final body fat. For Calibration, R58, R59, R60 parts should be connected in the above circuit diagram, and it should be controlled to have +(-) 1Vp-p in TP8

3.2 Result from Implementation

This display shows the test result of the body fat measurement by DDR function of Eclipse smart display capturing which is a tool for the development of Android.

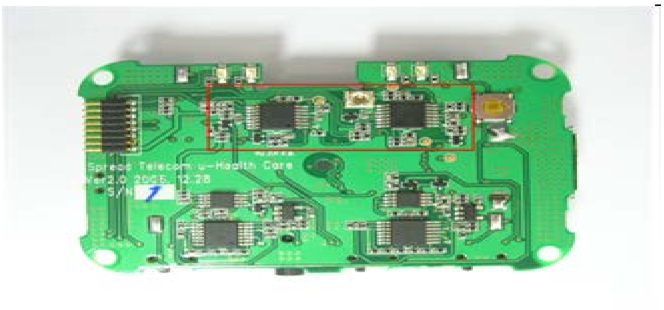

Fig. 2. BIO signal tested in the embedded board.

Figure 2 shows an example of a high Pass filter application. It can be seen that the clear electrocardiogram signal has come out by applying filter at channels 1, 2, and 3.

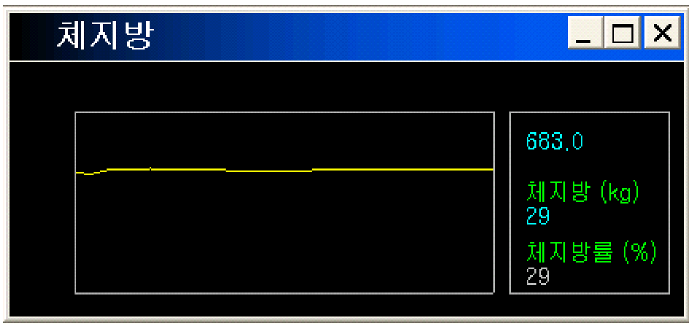

Fig. 3. BIO signal tested in the embedded board.

Figure 3 shows the display of electrocardiogram. More meaningful electrocardiogram data has come out by applying the filter previously explained.

4 Conclusion and Next Assignment

In this paper, for the accurate electrocardiogram measurement, the filter circuit, which can remove Low Pass Filter, High Pass Filter and Power Noise, has been implemented to reduce error caused by the noise of the measuring sensor in the system which measures the body fat signal.

In this paper, the App(application) of the body fat measurement has been implemented and displayed, which measures the body fat in the embedded system in which the Android has been porting

This means that it can simply diagnose not only an Android link electrocardiogram measurement system but also a real ubiquitous through various communication equipments and their methods.

Also, it has a merit to offer effective diagnosis service with low cost through linkage with the USN base system.

As this system can transfer data by using communication means based on Android, the next study about information security method should be done at the same time to protect information of a user.

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