IOSR Journal of Computer Engineering (IOSR-JCE)
e-ISSN: 2278-0661,p-ISSN: 2278-8727, Volume 22, Issue 1, Ser. IV (Jan - Feb 2020), PP 61-65
www.iosrjournals.org

Design of an Application based on Android framework for body fat measurement

Himanshu Bhusan Mohapatra[1], Ajit Kumar Mohapatra[2]
[1]*(Department of Electronics & Communication Engineering, Gandhi Engineering College, India)*
[2]*(Department of Electronics & Communication Engineering, Gandhi Institute For Technology, India)*

Abstract *As there has been recent fast development of a BIO signal measurement technology, our computing environment is rapidly shifting from existing desktop PC to Embedded System. Therefore, this paper has introduced an implementation of the body fat measurement system based on the Android Platform which has the same data precision as the one used in a hospital. The most important fact in most of the hospital equipments is that they need separate communication means which can help connection with PC, but in this paper, as we use the Android Platform in the Porting Embedded System, it is possible to measure body fat signal directly without separate communication means. We also have developed an application (App) program for the body fat measurement which can measure the body fat more conveniently and simple.*
Key Word*: BIO signal measurement, Android Platform, Porting Embeded System*

I. 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.

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%. 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.

For the body fat measurements, there are UWW(Under Water Weight), BIA(Bioelectrical Impedance Analysis), and TANITA BIA(Tanita Bioelectrical Impedance Analysis.) Among these, UWW is the most accurate method to measure the body fat.

From the differential between a weight measured in the air and a weight in the water, this method uses Archimedes principle to calculate the body density and then calculate the body fat percentage by composition and specific gravity of the body tissue. However, this method needs an equipment to immerge the body in water up to head for measurement so that it is not possible for a general use.

Currently, the simplest method to measure the body fat is BIA which uses a bioelectrical impedance. All matters have impedance electrically. BIA uses both the electrical characteristic of the human body which consists of highly conductive tissue(Conductor) and less conductive tissue(Insulator) and the fact that the ratio of the above two tissues is reflected in measured impedance. So it is called bioelectrical impedance analysis.

II. 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. 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 4. Its unit is Kg.

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

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

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

.

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.

GPAT, GHYU, GHOOT 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.

$$FM = W - FFM(Kg) \quad (2)$$

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

$$\%BF = (FM/W) \times 100(\%) \quad (3)$$

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

$$BMI = (W/H^2)\ (Kg/m^2) \quad (4)$$

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

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

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).

$$C = 1.11 \times (K_a \times W + K_b \times W^n) \quad (6)$$

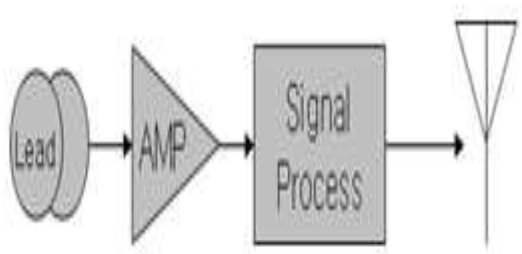
Ka denotes a living activity index, W a weight, Kb a basal energy metabolic rate, and n=0.424* constant.

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.

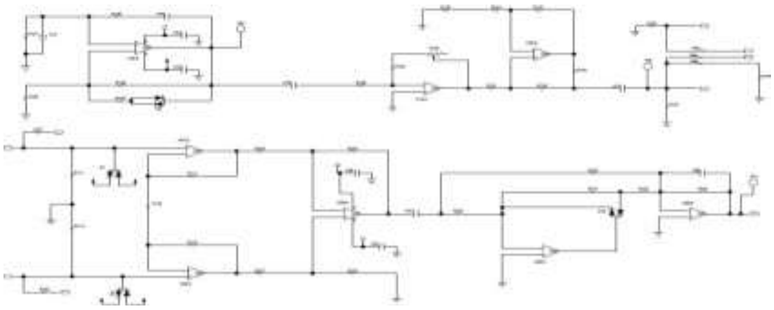
In case when he grabs electrodes properly, there is about 10% error compared to the product for common use. Figure 1 is a block diagram for the body fat equipment developed in this paper. This body fat equipment consists of a signal detection component which measures impedance from the body, an amplifying component which amplifies detected signal, a signal processing component for filtering and formatting the amplified signal, and a transferring component which transfers the processed signal.



[Figure 1] Components Diagram for Body Fat Equipment

III. Test and Result

How to measure the body fat



[Figure 2] Circuit Configuration to measure the body fat.

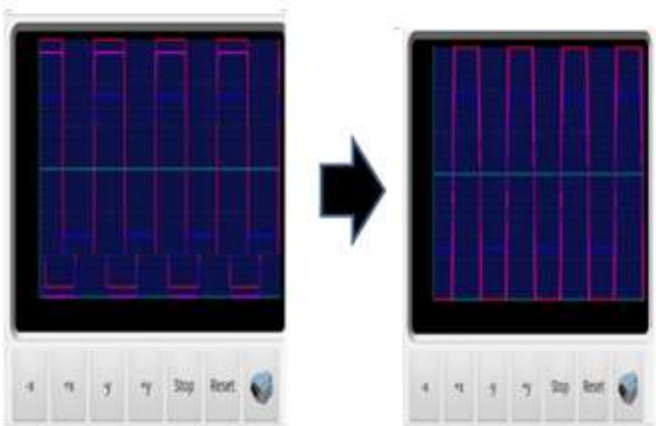
The above figure shows a circuit diagram for the measurement of the body fat. In the first component of the circuit diagram, there is a part which causes a frequency of 100 uA, 50 KHz entering into the body.
Due to a delicate difference in PCB pattern, in order to overcome the some voltage differential 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

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. Figure 8 is the result of the elctrocardiogram signal tested in the embeded board based on Android.



[Figure 3] raw Pass filter application display

The left signal in the figure 8 is the wave pattern before applying the filter, and the display on the right in figure 8 shows an example of an output when raw Pass filter is applied to the wave pattern of an electrocardiogram.

[Figure 4] high Pass filter application

Figure 4 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.

[Figure 5] Body fat measurement display of an embedded board based on the Android Platform.

Figure 5 shows the display of electrocardiogram. More meaningful electrocardiogram data has come out by applying the filter previously explained.

IV. Conclusions 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.

References

[1]. Albu, J. B., Kovera, A. J., Johnson, J. A. (2000) Fat distribution and health in obesity. Ann N Y Acad Sci **904**: 491–501.

[2]. Doll, S., Paccaud, F., Bovet, P., Burnier, M., Wietlisbach, V. (2002) Body mass index, abdominal adiposity and blood pressure: consistency of their association across developing and developed countries. Int J Obes Relat Metab Disord **26**: 48–57.

[3]. Visscher, T. L., Seidell, J. C., Molarius, A., van der Kuip, D., Hofman, A., Witteman, J. C. (2001) A comparison of body mass index, waist-hip ratio and waist circumference as predictors of all-cause mortality among the elderly: the Rotterdam study. Int J Obes Relat Metab Disord **25**: 1730–1735.

[4]. Rexrode, K. M., Carey, V. J., Hennekens, C. H., et al. (1998) Abdominal adiposity and coronary heart disease in women. JAMA**280**: 1843–1848.

[5]. Rexrode, K. M., Buring, J. E., Manson, J. E. (2001) Abdominal and total adiposity and risk of coronary heart disease in men. Int J Obes Relat Metab Disord **25**: 1047–1056.

[6]. Folsom, A. R., Kushi, L. H., Anderson, K. E., et al. (2000) Associations of general and abdominal obesity with multiple health outcomes in older women: the Iowa Women's Health Study. Arch Intern Med **160**: 2117–2128.

[7]. Peiris, A. N., Sothmann, M. S., Hoffmann, R. G., et al. (1989) Adiposity, fat distribution, and cardiovascular risk. Ann Intern Med **110**: 867–872.

[8]. Ansari, A., Rholl, A. O. (1986) Pseudopericardial effusion: echocardiographic and computed tomographic correlations. Clin Cardiol **9**: 551–555.

[9]. Savage, D. D., Garrison, R. J., Brand, F., et al. (1983) Prevalence and correlates of posterior extra echocardiographic spaces in a free-living population based sample (the Framingham study). Am J Cardiol **51**: 1207–1212.

[10]. Walsh, K. M., Leen, E., MacSween, R. N., Morris, A. J. (1998) Hepatic blood flow changes in chronic hepatitis C measured by duplex Doppler color sonography: relationship to histological features. Dig Dis Sci **43**: 2584–2590.

[11]. Janssen, I., Heymsfield, S. B., Allison, D. B., Kotler, D. P., Ross, R. (2002) Body mass index and waist circumference independently contribute to the prediction of nonabdominal, abdominal subcutaneous, and visceral fat. Am J Clin Nutr **75**: 683–688.

[12]. Marchington, J. M., Mattacks, C. A., Pond, C. M. (1989) Adipose tissue in the mammalian heart and pericardium: structure, fetal development and biochemical properties. Comp Biochem Physiol B **94**: 225–232.

[13]. Sahn, D., DeMaria, A., Kisslo, J., Weyman, A. (1978) The Committee on M-mode standardization of the American Society of Echocardiography: recommendations regarding quantitation in M-mode echocardiography: results of a survey of echocardiography measurements. Circulation **58**: 1072–1083.