Measuring Physical Fitness Condition System with Self Healthcare Capability Based on RFID Technology

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Abstract: This paper proposes a radio frequency identification-based (RFID-based) self healthcare management system which allows a user to identify his/her identification and measure/record their physical fitness and physiology conditions automatically. The system consists of a RFID tag, a RFID reader, a microprocessor-embedded main control system, and several peripherals, including blood pressure meter, ear-temperature meter, and body-weight meter, balance measurement, speed test for running back-forth measurement, etc. The RFID tag and reader are used to store and read a user's identification, physical fitness condition as well as physiology data. The main control system with MINI2440 ARM microprocessor and WinCE 6.0 platform embedded would identify the user's identification and then initiate the peripheral device to measure his/her physiology conditions. The measured data is then transmitted and stored in the RFID tag and database. The user interface and database are built by C++ codes. According to the experimental results, the proposed system with easy operations allows users to finish the process of measuring a user's physiology conditions in 3 minutes and allows users to output the measured data coupled with users' body mass index (BMI) for self health management references and support medical diagnosis to qualify the medical treatment, rehabilitation or training in advance.

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1. Introduction

In order to have longer life and increase life quality, people generally would trace their health conditions and prevent/control diseases and their physiology conditions by two ways, including taking time to hospital for periodical diagnostic personally or purchasing the health instruments for measuring their physical fitness conditions ordinarily. These reactions can be explained by the statement -- a good gauge of the risk for diseases that can occur with more body fat is associated with body mass index (BMI); the higher BMI will cause the higher risk for certain diseases such as heart disease, high blood pressure, type 2 diabetes, gallstones, breathing problems, and certain cancers [1]. For more examples, Crespo et al. [2] and Eissa et al. [3] discussed the association of the physical activity, physiology conditions, and diseases. Crespo et al. analyzed the data for the relationship between physical activity and overweight status to all-cause mortality in 9,136 men. Eissa et al. found that each 1-unit increase in physical activity was associated with an increase in systolic blood pressure of 0.02 mm Hg, in diastolic blood pressure of 0.01 mm Hg, and in heart of 0.02 beat/min. The conclusion made is that the association of blood pressure with physical activity was significantly less for those with higher BMI. Similar issues also have been studied specifically for American youth [4], Japanese women [5], Chinese American children [6], and Australians [7]. In addition, several references have stated that monitoring blood pressure [8-9], body temperature [10-11], and weight loss or gained [12-13] are important to raise life index quality and lead to a longer life expectancy. Sain et al. [14] also mentioned that user healthcare data like ECG and temperature is important for basic healthcare needs.

However, the method for taking time to hospital is energy and time consuming; the method for self measuring health condition is usually based on hand writing for storing the measured data. This implies collecting and connecting these measured medical data are ineffective and inconvenient. The reference [15] proposed a sensor-based homecare health-alert system for older people and suggested that there is a need for automatic sensor-based personal healthcare systems. Therefore, to overcome the weaknesses described above, this paper applies radio frequency identification (RFID) technology to provide the advantages of storing /reading data quickly, processing large volumes of multiple data sets at the same time, improving efficiency of operations, and accurately monitoring processes for people.

RFID technology provides the advantages of storing/reading data quickly, processing large volumes of multiple data sets at the same time, improving efficiency of operations, and accurately monitoring processes for people [16]. Several references [17-23] have applied RFID technology to manage medical data effectively and efficiently. Hsu [17] designed an intelligent real time healthcare system for far-end users. Chang [18] proposed a RFID-embedded system with capable of monitoring users' electrocardiogram (ECG) signals for long-distance self healthcare application. Lo, et al. [19] discussed the potential of RFID technology in healthcare industry. Meiller et al. [20] developed a knowledge-based system for healthcare applications with RFID generated information. Huang et al. [21] proposed the limb prosthesis healthcare self-training system. The RFID readers and tags are employed to acquire the 3D positioning information of the amputee's limbs in this work to assist in diagnosing the amputee's walking problem. Lee et al. [22] and Shih [23] used RFID technology to design a body fat or blood presssure management system with the capabilities of remote monitoring and sounding suggestions.

Therefore, this study proposes a RFID-based physical fitness condition measuring system which allows a user to identify his/her identification and measure/record their physical fitness and physiology conditions automatically. The measured outputs of the proposed system has the advantages of supporting medical diagnosis to quantify the medical treatment, rehabilitation or training as well as managing medical data effectively and efficiently. Moreover, it is compatible with most medical measurement instruments and supports easy operations. In the following, Section 2 describes the proposed self health management system. The experimental results are shown in Section 3. Finally, the conclusion and future works are summarized in Section 4.

2. Physical fitness measuring system

Figure 1 gives the system block diagram of the proposed physical fitness condition measurement system. The system includes two parts: computer and measurement. As given in Figure 1(a), the computer obtains the measured physical fitness conditions from the RFID tag via RS232 transmission cable and a user friendly interface is built by using C++ programming language. As given in Figure 1(b), the measurement part of the system consists of a RFID tag, a RFID reader, a main control board, and eight kinds of peripherals including (1) blood-pressure meter, (2) ear-temperature meter, (3) body-weight meter, (4) body-height meter, (5) body-balance meter, (6) running back/forth test, (7) thrusting forward to ground test, and (8) lying-down/sitting-up test. The RFID tag and reader are used to store and read a user's identification as well as physical fitness conditions. The main control board would process the user's identification and initiate the peripheral device to measure his/her physical fitness conditions. Each function of the system is described in the following.

A. RFID tags and readers

Figure 2 shows the pictures of RFID reader and tag, which is compatible with the international ISO-15693 standard. The RFID tag and reader are used to store and read a user's identification as well as physical fitness condition data. The RFID reader uses ISO 18000-3 13.56 MHz band for data transmission. Table I shows the data format of the RFID tag. The first and the last block are fixed to 02 and 03. The RN stores the tag's identification, LEN stores the data length (D0 … DN). The RFID tag totally has 28 data blocks for read/write. INS stores the operating function codes. For example, the code 02 means read and 06 means write. LRC stores the checksum code. Table II gives the data location of a user's identity and physical fitness conditions, including their ID number, name, blood pressure, height, weight, and so on.

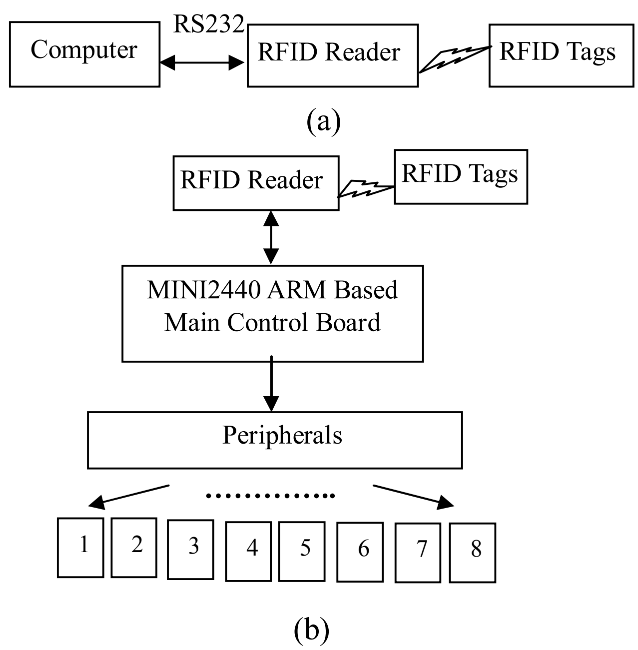
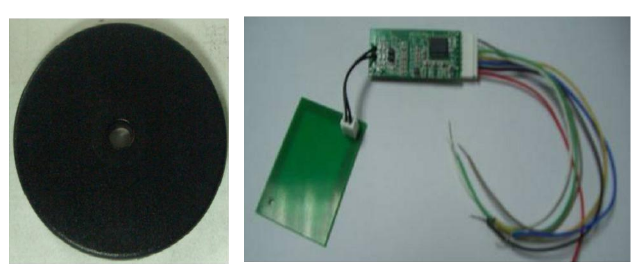


Figure 1. System block diagram of the (a) computer part; (b) physical fitness condition measurement part.



(a) (b)

Figure 2. (a) RFID tag; (b) reader.

Table 1. The data format of the RFID tag.

02	RN	LEN	INS	D0	…	DN	LRC	03

Table 2. The data location of a user's identity and physical fitness conditions

Block	Data Contents
13	Diastolic blood pressure, and heart beat rate
14	Temperature, balance, and lying-down/sitting-up
15	Weight, running back/forth, and thrusting forward to ground
16	Height and systolic blood pressure
17	Middle name
18	First name
19	Last name
20	Identification number

B. Microprocessor-embedded main control system

Figure 3 shows the circuitry block diagram of the main control board which is based on MINI2440 development board with Samsung S3C2440 ARM9 microprocessor. The system control board coupled with software control codes would process a user's identification and initiate the measurement end to measure his/her physical fitness conditions. The hardware measurement ends includes 8 peripheral devices as stated above. The RS232 transmission interface is used to connect MINI2440 development board with the measurement ends, RFID reader, and tag. The measured data is then transmitted and stored in the RFID tag. The system components are described in the following.

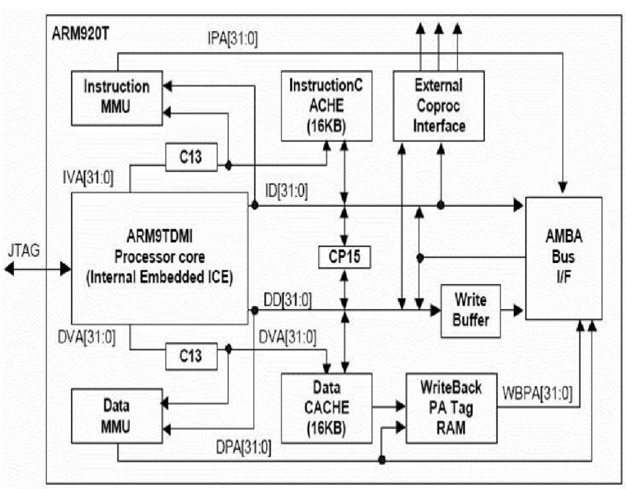


Figure 3. Circuitry block diagram of the MINI2440 development board with Samsung S3C2440 ARM9 microprocessor.

C. Soft

D. ware control codes

Figure 4 shows the flow chart of software control codes, which starts at reading the RFID tag data. After the system read the data, it shows the user's name and identification on the screen and initiates the measurements via RS232 transmission line. The system will wait until the measured data is obtained. The system then stores the measured data in the RFID tag and database.

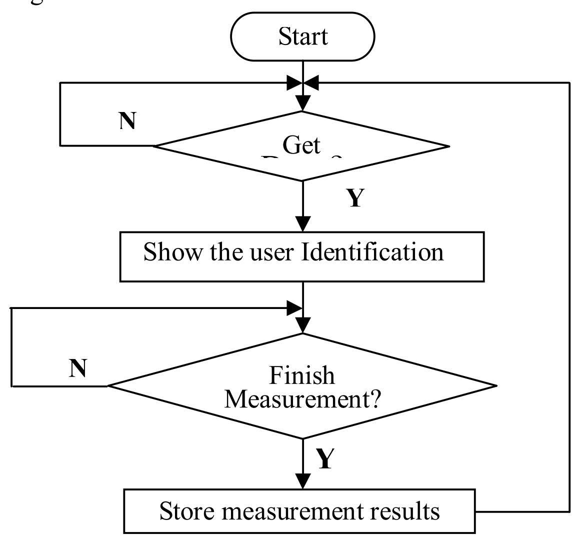


Figure 4. Flow chart of software control codes.

E. Eight peripheral measurement ends.

Three categories for measuring a user's physical fitness condition with eight peripheral measurement ends are given in Figure 5, 6 and 7, respectively. Before starting the measurement, the main control device reads the user's identification from their RFID tag, the user's name and identification is shown on the screen and the measurement is then initiated via RS232 serial transmission line. After the device obtains the measured data, the buzzer sounds and the measured data is stored back in the RFID tag.

Figure 5 gives the block diagram of blood-pressure, ear-temperature, body-height, and body-balance measurement ends, where the ultrasonic distance and load cell sensors are used for measuring the user's height and body balance ability. Figure 6 gives the block diagram of body-weight measurement end. The obtained measured data is transmitted by RS485 interface and then sent to the device by RS232 serial communication interface. Figure 7 gives the block diagram of running back/forth, thrusting forward to ground, and lying-down/sitting-up test measurement ends. Two optical sensors are used for the measurements.

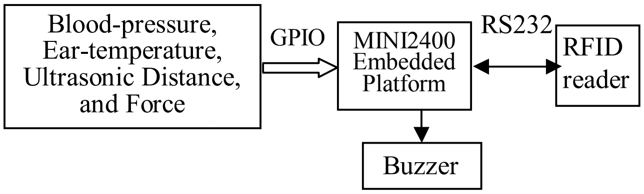


Figure 5. Block diagram of blood-pressure, ear-temperature, body-height, and body-balance measurement ends.

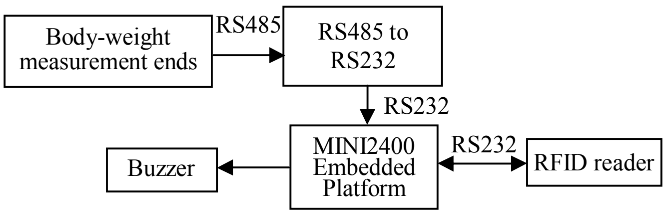


Figure 6. Block diagram of body-weight measurement ends.

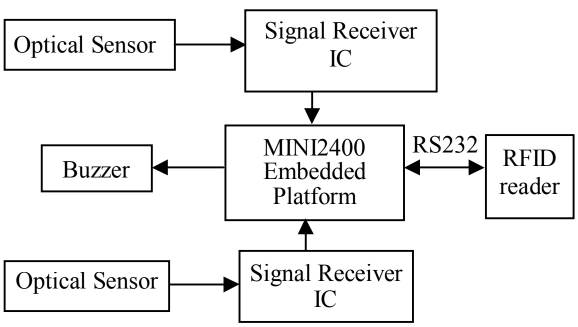


Figure 7. Block diagram of running back/forth, thrusting forward to ground, and lying-down/sitting-up test measurement ends.

F. The User Interface.

Figure 8 shows the structure of the user interface at the computer part of the system, which has six main functions, including NEW, ANALYSIS, PREVIEW, PRINT, SHOW, and EXIT. NEW is for creating a new user; ANALYSIS is for data analysis; PREVIEW is for output preview; PRINT is for printing the output; INFO is for showing the users information, the measured physical fitness data, and recommendations; and EXIT is for exiting the system.

3. Experimental results

Figure 9(a) shows the user interface starting window at the computer part of the system, which is coded by using C++ programming codes. There are six main functions shown on the bottom part of the screen, including creating a new user, data analysis, output preview, print results, health information, and exit. The user's personal information, including identification, name, age, gender, measuring date, and personal picture, is given on the left part of the screen. The measured data are shown at upper part of the screen and the analysis of the measured data is given on the middle part of screen. Finally, the suggestions are given at above of the main function bar. Figure 9(b) gives the creating a new user window in Chinese. At this window, the system automatically generates an identification for a user; the user has to fill out his/her name and gender.

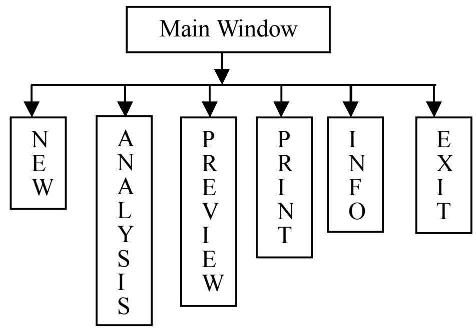


Figure 8. Structure of the user interface at the computer part of the system.

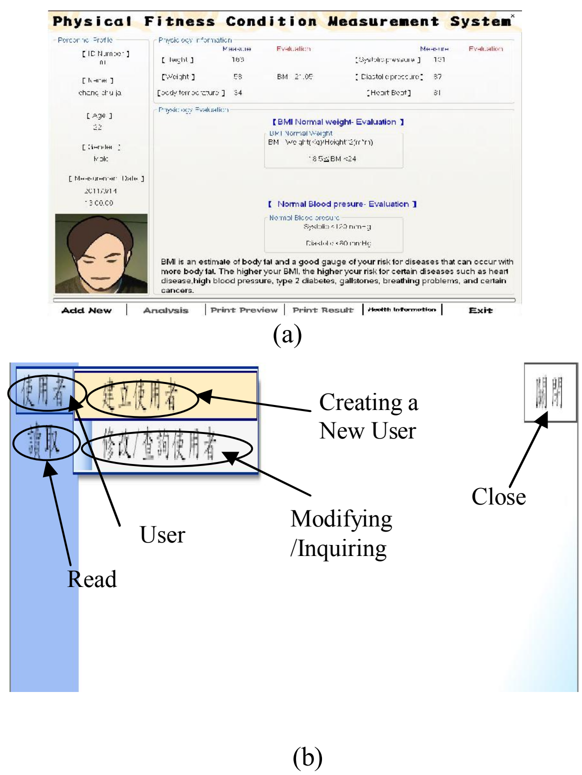


Figure 9. User interface starting window at the computer part of the system.

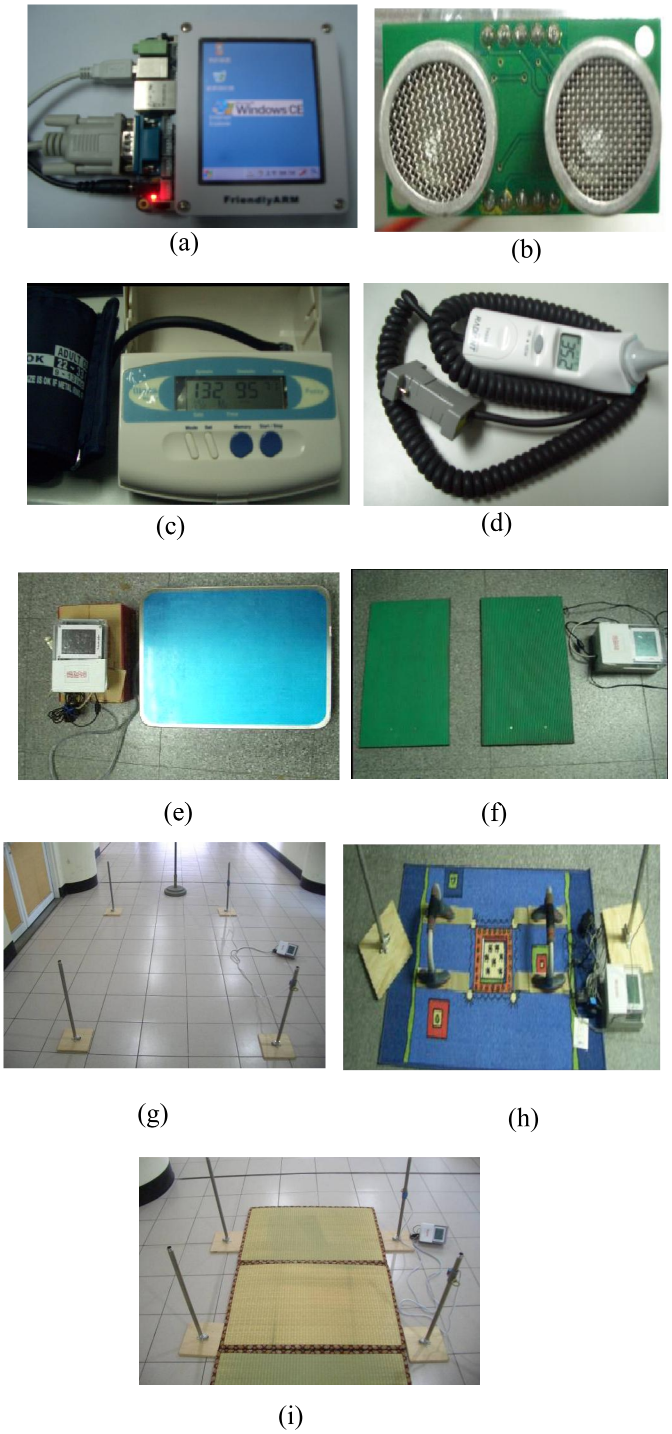


Figure 10. Measurement-ends' pictures of (a) the main control board, (b) body-height, (c) blood-pressure, (d) ear-temperature, (e) body-weight, (f) body-balance (g) running back/forth, (h) thrusting forward to ground, and (i) lying-down/sitting-up.

Figure 10 shows the measurement-ends' pictures of (a) the main control system, (b) body-height, (c) blood-pressure, (d) ear-temperature, (e) body-weight, (f) body-balance (g) running back/forth, (h) thrusting forward to ground, and (i) lying-down/sitting-up. As given in Figure 10(a), the connection between embedded system and measurement ends is based on RS232 cable. The operating system used in this study is Window CE. According to Figure 4, a user utilizes his/her RFID tag to start the measurement process—obtaining the data. After finishing the measurements, the user attaches the RFID tag to the RFID reader at the main terminal of the embedded system; the measured facts are stored in the RFID tag and are then updated in the database of the embedded system.

4. Conclusions

In this paper, a RFID-based physical fitness measurement system is proposed to allow a user to identify his/her identification and record their physiology conditions automatically. The proposed measurement system supports three advantages: (1) the develop of the user friendly interface at the computer terminal with the recommendation provides users to record their measured physical fitness conditions in the database which gives users and their family inquiry past measurement records that can be downloaded and printed for self health management references; (2) as shown in the experimental results, the proposed system with easy operations allows people to use the outputs of the measured data coupled with users' body mass index (BMI) for supporting medical diagnosis to qualify the medical treatment, rehabilitation or training; (3) the use of RFID technology would identify users correctly and efficiently, specifically for elders who are not capable of using a computer to key in their identification or who might make mistakes due to keying the wrong identification. This work can be extended to focus on building a commercial product which can make a simple diagnosis or medical suggestion whenever a user finishes the measurements.

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