Design of Biological Information Measuring System

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Abstract: To monitor individual's health status, and collect vital physiological data, a biological information measuring system was developed in this paper. As a first step of our research, a user's unit which had an accelerometer and thermometer was made and verified its performance. From the experimental results, it was clear that a healthy subject's activities and the body temperature were appropriately collected using the system.

Keywords: biological information measuring, accelerometer, thermometer

1. Introduction

Japan is facing a fast increasing population of elderly citizens. From the influence, the single elderly people who live alone are increasing. Therefore, some of them are not immediately found when they are injured in a sudden accident, or when a sudden sickness occurs. In the worst case, some of them result in death. It is thought that one of solutions to this is a biological information measuring system. Final goal of this research is to continuously monitor the individual's health status, collect vital physiological data, and report their abnormal statuses to their regular doctors. As a first step of our research, a user's unit which had an accelerometer and thermometer was made and verified its performance in experiments.

2. System Configuration

System configuration of the biological information measuring system we made is shown in Fig. 1. The user's unit is composed three parts: an accelerometer [1], thermometer, and wireless communication unit. To monitor a user's activities, we utilized an acceleration sensor ADXL202, Analog Devices, Inc. The ADXL202 is a low-power and 2-axis accelerometer with a digital output, all on a single monolithic IC. This sensor can output analog voltage or digital signals whose duty cycles (ratio of pulse width to period) are proportional to acceleration. The duty cycle outputs are measured by the PIC16F876 in the circuit. The accelerometer was also used to detect the user's abnormal activities, such as a falling, and motionlessness.

In order to measure the user's body temperature, a temperature sensor LM35DZ, National Semiconductor Corp., was used. The output voltage of LM35DZ was amplified to adjust its sensitivity by an Op. Amp. LMC662CN, National Semiconductor Corp, the amplifier's output was sampled by the PIC16F876 to measure the user's body temperature. This unit has an EEPROM 24LC256 to store data as well as a level converter ADM232AAN to connect to the host during setup.

For data transmission between the biological information measuring system and a host PC, a pair of ZigBee module ZIG-100B [2], Best Technology Co., Ltd., was utilized. ZigBee is a low-power and short-distance wireless communication standard for 2.4 GHz band. This device has the ability to form a mesh network between nodes. Meshing is a type of daisy chaining from one device to another. This technology allows the short range of an individual node to be expanded, covering a large area [3].

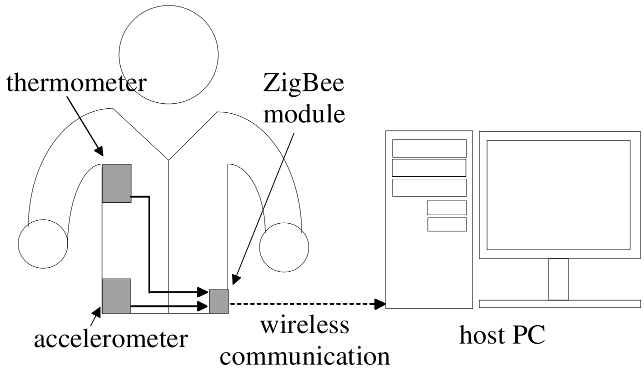

Fig. 1 System configuration of biological information measuring system.

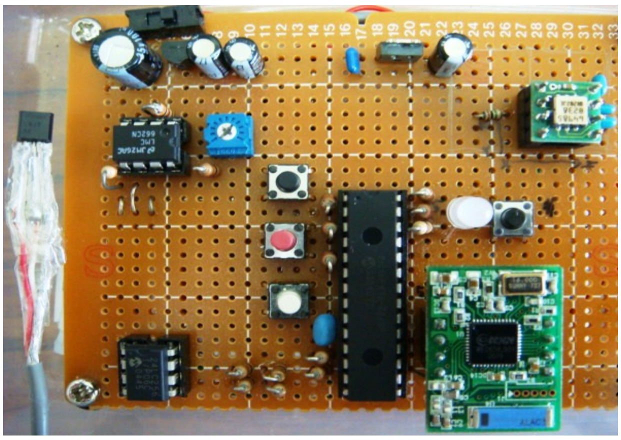

Fig. 2 Prototype user's unit of biological information measuring system.

The outputs of the accelerometer and thermometer were transmitted to the host PC using ZibBee's international standard protocol. A transmission rate in this device can be set to the range from 9600 to 230,400 kbps. The prototype user's unit of biological information system is shown in Fig. 2. In the circuit, measuring data such as the output data of acceleration and temperature sensors are stored to the EEPROM 24LC256, and the stored data are transmitted to the host PC by the ZigBee device. We used the MPLAB IDE Ver.6.60 (Microchip Technology, Inc.) and CCS's (Custom Computer Services Inc.) C compiler as a program development environment [4].

3. Method

Using the system, activities and the body temperature of a healthy subject, 22-year old, male, were measured for about 8 hours in a daily living. The user's unit was fixed to his waist. The positive directions of x- and y- axes of the acceleration sensor were set to user's upward and his traveling direction, respectively. The acceleration data were accumulated and calculated for 30 seconds. The temperature sensor was also fixed under his arm. The temperature sensor's sensitivity was adjusted using a commercially available clinical thermometer before the experiments. To easily feed the body temperature information back to the user, an LED on the user's unit was set to turn on a green light under the temperature of 36.5 deg. Celsius, a yellow light for the temperature ranges between 37.0 to 38.0 deg. Celsius, and a red over the temperature of 38.0 deg. Celsius, respectively. An average body temperature for 30 sec was calculated. We also set to every hour interval of data transmission from the user's unit to the host PC.

The user's unit has three switches. One of them is for the start of data measurement, and the others are for the start of data transmission and reset. A flowchart of measurement mode is shown in Fig. 3. When the measurement mode starts, all the measurement data in the EEPROM are cleared at first. After that, the user's unit starts to measure the user's acceleration and the body temperature for 30 seconds. Every 30-second measurement data is restored in the EEPROM, and measure it again. This is repeated for an hour, and measurement data for an hour are transmitted to the host PC. In the user's unit, this procedure is repeated, and the measurement will stop at the measurement time. In order to verify the measured data in the EEPROM, they are sent to the host PC by pushing the transmission switch. When a problem occurs during a measurement, the user's unit can be reset by pushing the reset switch. A six-secondary AA size battery connected in series was used to drive the user's unit in the experiments.

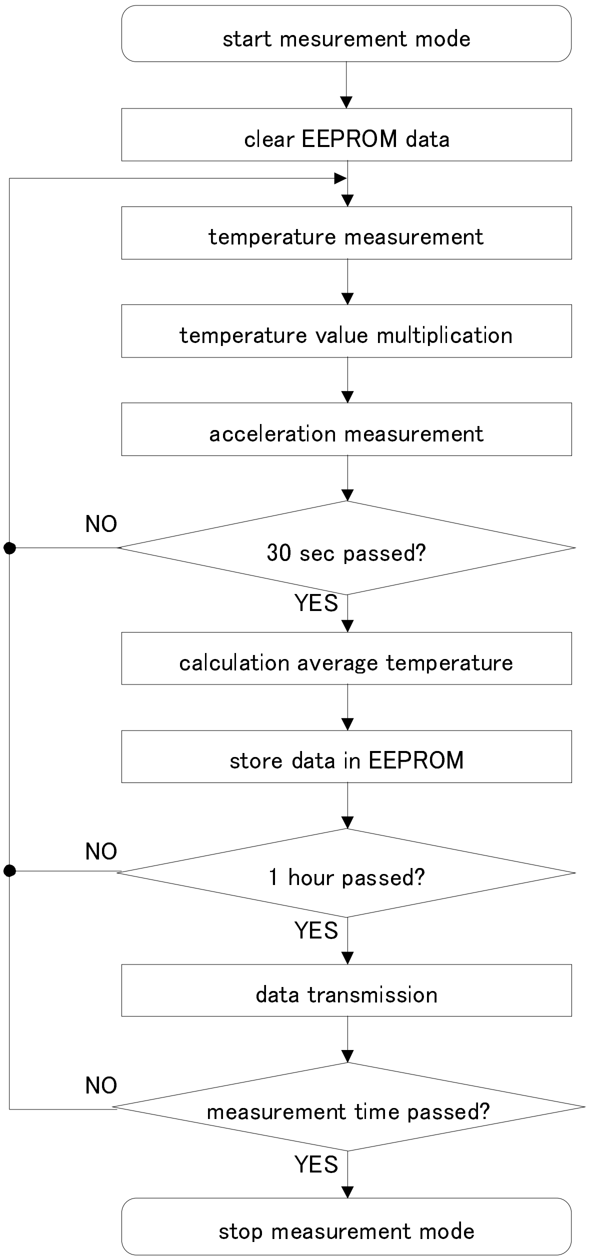

Fig. 3 Flowchart of measurement mode.

4. Experimental Results

An example of experimental results of measuring the body temperature and user's acceleration is shown in Fig. 4, and the relationship between measurement time and subject's activities during experiment is shown in Table 1. It is found from Fig. 4 that the output of accelerometer changes according to the user's activity as shown in Table 1. From this result, it is clear that the acceleration sensor of the user's unit can be useful to measure the user's activities. From the body temperature measurement results, it is thought that the temperature sensor can be appropriately obtained the user's temperature. Therefore, it is obvious that the circuit we made can measure the subject's body temperature in daily living. Moreover, it is clear that the host PC can correctly receive the measurement data every hour using the ZigBee module. The user's unit powered by the secondary cell battery can measure the user's activities and the body temperatures more than 100 hours.

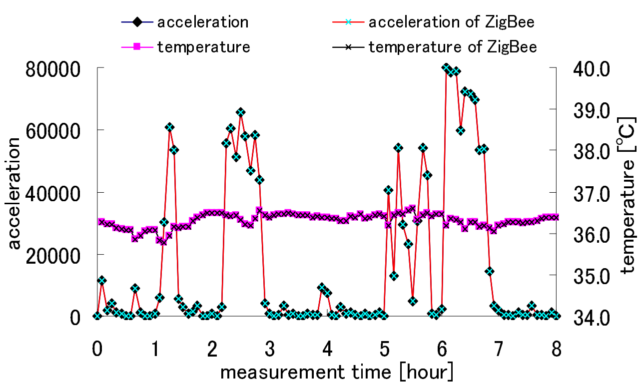

Fig. 4 Experimental results of acceleration and body temperature measurement.

Table 1 Relationship between measurement time and subject's activities.

measurement time [min]	subject's activities
0-70	at home
70-80	walking
80-130	desk work
130-170	walking
170-300	desk work
300-345	walking
345-360	desk work
360-405	walking
405-480	desk work

5. Conclusion

The user's unit which had the accelerometer and thermometer for the biological information measurement system was made, and the healthy subject's activities and his body temperature were measured in the experiments. From the experimental results, it is clear that the user's activity and body temperature can be measured. A consideration of measuring a user's heart rate of the biological information data should be needed for our future work.

References

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