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A WEARABLE POSTURE, BEHAVIOR AND ACTIVITY RECORDING SYSTEM

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ELECTRONIC ENG. BME LAB.

INTRODUCTION

Numerous types of human activity recording systems have been developed for measuring the duration and timing of sleep/wake conditions. These systems are limited by recording only general activity. However, it is important to record detailed posture, behavior and activity data for monitoring health conditions and living patterns.

In this study, a new posture, behavior and activity recording system, which consists of a dual axis accelerometer, low and high pass filters, a microcontroller and a 320KB EEPROM, has been developed. Using a two-second sampling rate, the microcontroller detects whether the patient is moving or inactive; if movement is sensed, it is recorded by the EEPROM. If the patient is at rest, posture is recorded. The mean activity is recorded at one-minute intervals.

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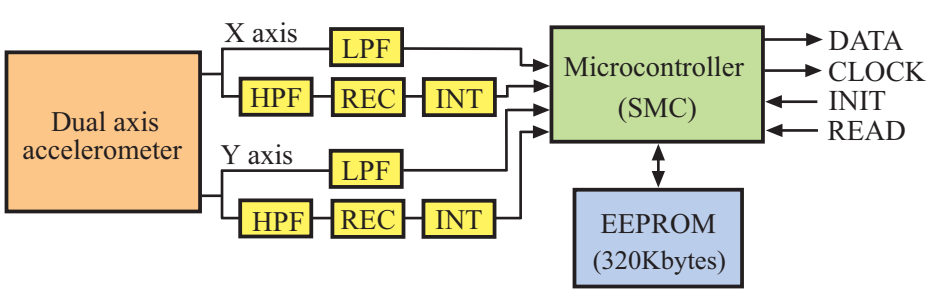
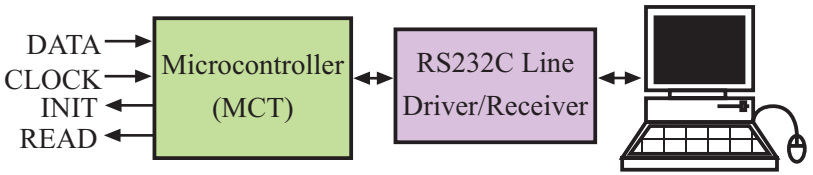
SYSTEM DESCRIPTION

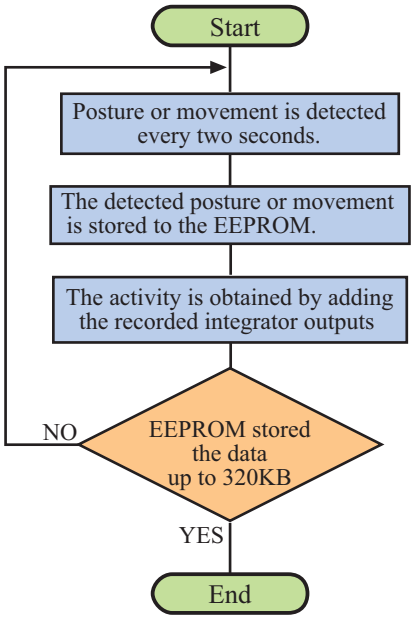


(a) Posture, behavior and activity recorder

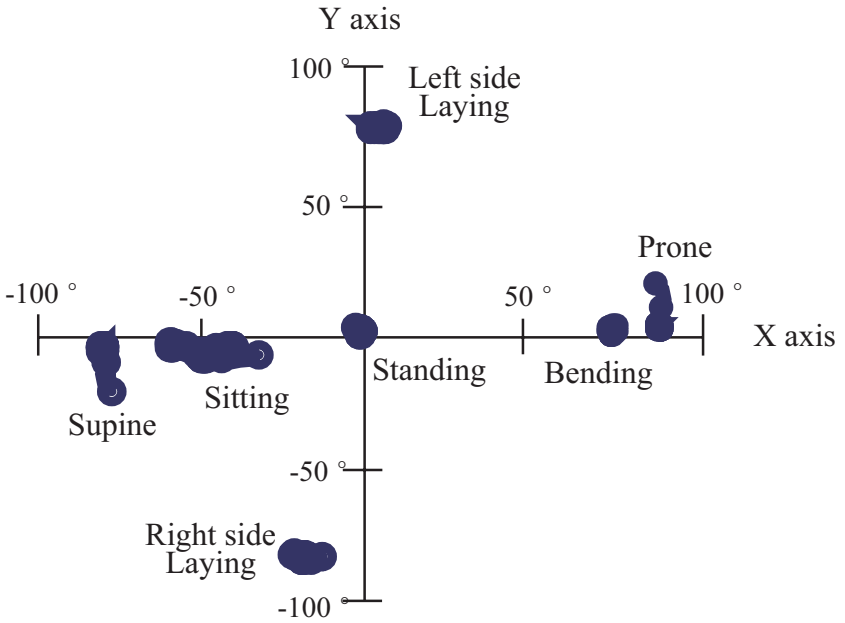


(b) Data terminal adapter

Fig.1 The overall wearable posture, behavior and activity recording system. The system consists of a dual axis accelerometer (Analog devices, ADXL202), low and high pass filters, rectifiers, integrators, a SMC microcontroller (Micro chip Technology, PIC16C711) and a 320KB EEPROM (Atmel, AT24C512). After recording for 10 days, the recorded data are read out by the data terminal adapter, which consists of a microcontroller(MCT), a RS232C line driver/receiver and a personal computer.



(a) The flow chart of the recording system



(b) X and Y axis tilt angles in various postures

Fig.2 The flow chart of the recording system. The A/D converters simultaneously sample the integrator outputs at 100 Hz. The SMC continuously monitors the integrator outputs every two seconds and detects whether the patient is moving or resting. If the patient is moving, the SMC detects from the X and Y activities whether the patient is walking or running. If the patient is at rest, the SMC detects from the X and Y axis tilt angles whether the patient is standing, sitting or laying. These detected movements and posture are coded by 4 bit binary code and stored to the EEPROM. The mean activity is obtained by adding the recorded integrator outputs for 1 minutes and stored to the EEPROM.

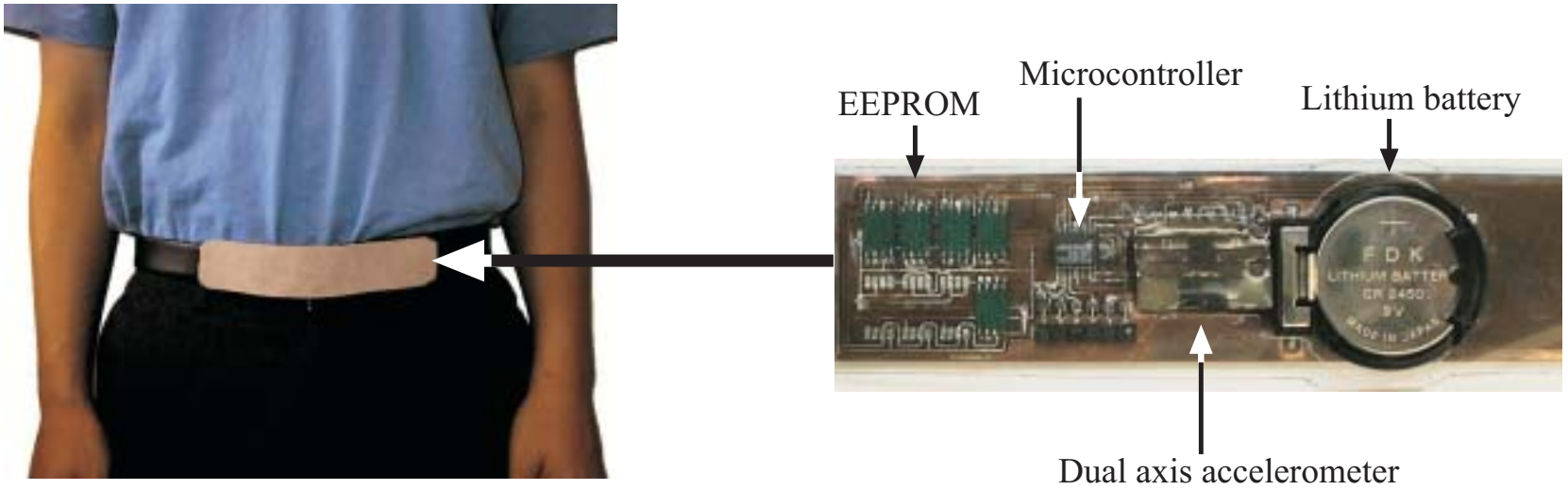


Fig.3 The wearable posture, behavior and activity recorder. The 15 gram circuit is constructed on one 30 X 117 mm PC board. The system is powered by a small 3 V lithium battery, which provides 10 days of continuous operation. Measurements were performed on three normal age 23 male subjects, who wore the system on the center of the abdomen with a waist band for 10 days.

RESULTS

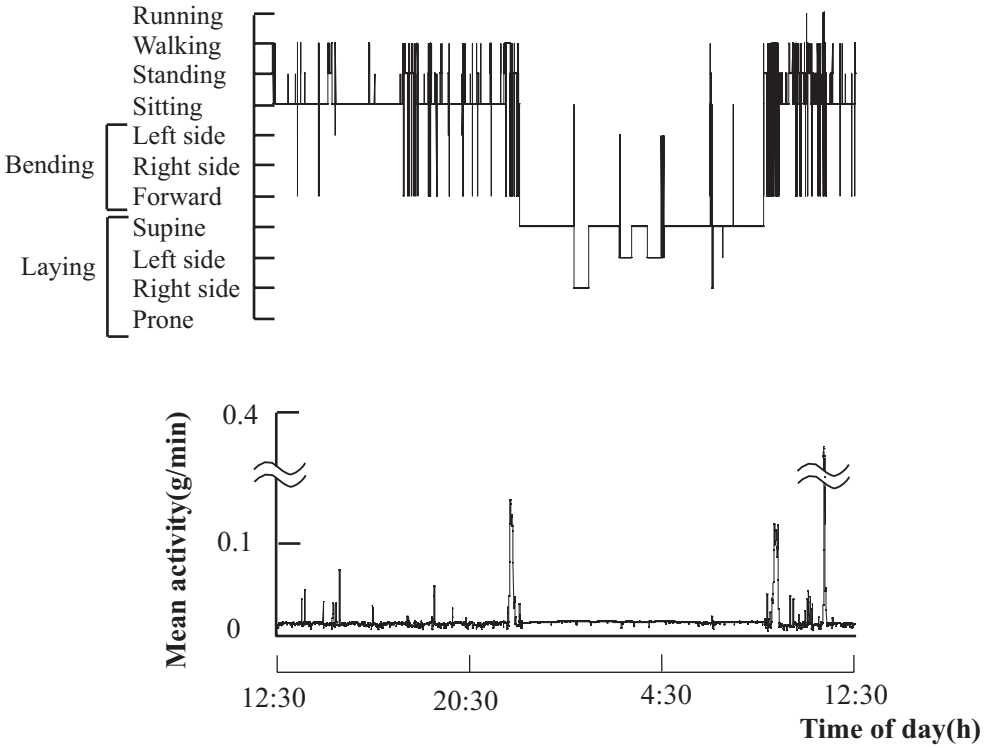


Fig.4 Typical data recorded by the developed system for 24 hours. Whether the patient is walking or running can be detected from the activity level. When the activity is low level, then the posture is identified as either standing, bending, sitting or laying. The activity patterns and circadian phase data are all easily determined from the recorded data.

CONCLUSION

The developed system employs the small low power dual axis accelerometer, which can measure both static and dynamic acceleration forces simultaneously. The static acceleration forces indicate the two axis tilt angles. The integrated X and Y dynamic acceleration forces are identified as mean activity. The posture and behavior can be detected by these two axis tilt angles and activity. The subject's general health condition and living patterns, as well as the effects of many immediate physiological and psychological conditions, may be obtained from these posture, behavior and activity data.