A MICROCOMPUTER-BASED LIFE-SAFETY MONITORING SYSTEM FOR ELDERLY PEOPLE

Hiromichi Maki[1], Yoshiharu Yonezawa[2], Hidekuni Ogawa[2], Ishio Ninomiya[3], Kouji Sada[4], Shingo Hamada[4]

[1]International Trinity College, Kaminobori 8-18, naka-ku, Hiroshima.

[2]Hiroshima Institute of Technology, Miyake 2-1-1, Saiki-ku, Hiroshima.

[3]Hiroshima International University, Gakuendai 555-36, Kurose, Hiroshima.

[4]Shakaihoken Shimonoseki Kousei Hospital, Shinchi3-3-8, Shimonoseki, Yamaguchi.

Abstract - **A new safety and life support system has been developed for monitoring health conditions and daily living activities of solitary elderly people. The system employs a piezoelectric sensor, two low-power active filters, a low-power 8-bit single chip microcomputer (SCM) and a 315 MHz radio transmitter. The body movements produced by respiration, heartbeat, sleep/rest motions, walking and running are detected by the piezoelectric sensor, and the recorded motion signals are inputted to the SMC. If the patient is inactive for 64 minutes, then the SMC detects this emergency situation and informs the patient's family, a fire station or a hospital via telephone. The system is powered by a small 3V lithium battery, which provides 14 days of continuous operation.**

Keywords - **Solitary elderly people, Life safety, Body movement, Piezoelectric sensor**

I. INTRODUTION

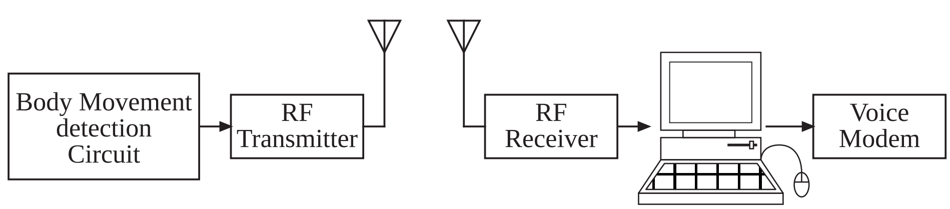
The sudden death of solitary-living elderly people is now a serious problem in many countries. The main causes are cardiopulmonary cessation and cerebral vascular accident. Numerous types of human activity recording systems [1,2] have been developed for recording posture, behavior and activity and for monitoring health conditions and living patterns, such as activity/rest time periods, sleep quantity and quality, general activity level and circadian rhythms. However, these systems cannot detect whether the solitary elderly person is in a safe physical condition.

In this study, the microcomputer-based safety monitoring system detects the persons life-threatening physical condition and reports the emergency via telephone phone to the patient's family, a fire station or a hospital.

II. SYSTEM DESCRIPTION

Fig.1 shows the life-safety support system, which consists of a body movement detector and an emergency call device (ECD). The detector, attached to the patient's abdomen, detects an emergency situation from body movements produced by respiration and heartbeat and lack of intermittent lower body motion. If an emergency situation is detected, then the ECD is activated to make the telephone report.

Figure 2 shows the body movement detector block diagram. The detector employs a piezoelectric sensor (Pennwalt, Kynar



(a) Body Movement detector (b) Emergency call device

Fig. 1 Solitary old people safety life support system

Report Documentation Page

Report Date	Report Type	Dates Covered (from... to)
25 Oct 2001	N/A	-

Title and Subtitle A Microcomputer-Based Life-Safety Monitoring System for Elderly People	**Contract Number**
	Grant Number
	Program Element Number
Author(s)	**Project Number**
	Task Number
	Work Unit Number
Performing Organization Name(s) and Address(es) International Trinity College Kaminobori 8-18 , naka-ku Hiroshima	**Performing Organization Report Number**
Sponsoring/Monitoring Agency Name(s) and Address(es) US Army Research, Development & Standardization Group (UK) PSC 802 Box 15 FPO AE 09499-1500	**Sponsor/Monitor's Acronym(s)**
	Sponsor/Monitor's Report Number(s)
Distribution/Availability Statement Approved for public release, distribution unlimited	
Supplementary Notes Papers from 23rd Annual International Conference of the IEEE Engineering in Medicine and Biology Society, Oct 25-28, 2001, held in Istanbul, Turkey. See also ADM001351 for entire conference on cd-rom.	
Abstract	
Subject Terms	
Report Classification unclassified	**Classification of this page** unclassified
Classification of Abstract unclassified	**Limitation of Abstract** UU
Number of Pages 4	

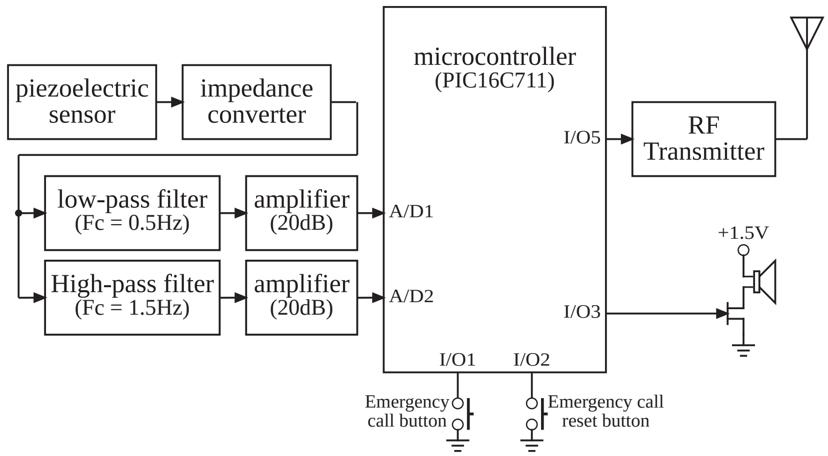


Fig. 2 The body movement detector block diagram

Piezo Film), an impedance converter, two low-power active filters, two low-power amplifiers, a SMC low-power 8-bit single chip microcontroller (Micro chip Technology, PIC16C711) and a 315 MHz radio transmitter. The piezoelectric sensor, whose electrical polarization is produced by mechanical strain, detects body movements produced by respiration, heart pulse, walking and running. The piezoelectric sensor is a very high output impedance device and its charge developed by an applied force decays with a time constant defined by the electronic interface input resistance and the sensor film capacitance. Therefore, the sensor requires an impedance converter with a high input resistance. The impedance converter is designed with two FETs (Field Effect Transistor) and a 10M ohm input resistor.

The converter output is fed into low and high-pass filters. The 0.5 Hz low-pass filter detects the major respiratory component of slow body movements. The 1.5Hz high-pass filter detects the high frequency components produced by the heart pulse, walking and running.

Each of filter outputs is amplified by 20 dB gain DC amplifiers. The amplified signals are fed into the SMC analog converters. The SMC employed is an 8-bit CMOS RISC-like CPU with four analog converters. A/D1 and A/D2 converters sample the amplified signals at 40Hz.

The SMC detects whether the patient is an emergency situation from the body movements. The body movements are recorded as normal as long as the subject goes about their daily activities and rest/sleep movements without physical abnormalities. When the body movements (low and high-pass filter outputs) become less than the signal noise levels, the SMC detects this life-threatening state and sends the call to the patient's family or emergency services.

If the elderly person falls into a comatose state, then the body movements due to respiration and heart pulse are still normally recording. Therefore, the system performs the very important function of discriminating between normal rest or sleep and a dangerous shock or comatose state. In this study, the continuance of the rest state was recorded on ten normal age from 51 to 88 subjects, who wore the system on the center of the abdomen with a waist band for 24 hours.

Fig. 3 shows the frequency distribution histogram for the continuance time of the rest/sleep state. If the patient is inactive for 64 minutes, which is not normal even in deep sleep, a buzzer warning sound is activated for one minute. If the patient does not respond, then the SMC, via the radio transmitter, informs the ECD of the emergency situation.

The 15 gram circuit is constructed on one 30 x 50 mm PC board. Power requirement 5.1 mW, as supplied by a small 3 volt, 600 mAh lithium battery.

The ECD consists of a RF receiver, a personal computer and a voice modem. When the RF receiver received the emergency situation, then the personal computer informs it via the voice mode to the patient's family, the fire station or the hospital.

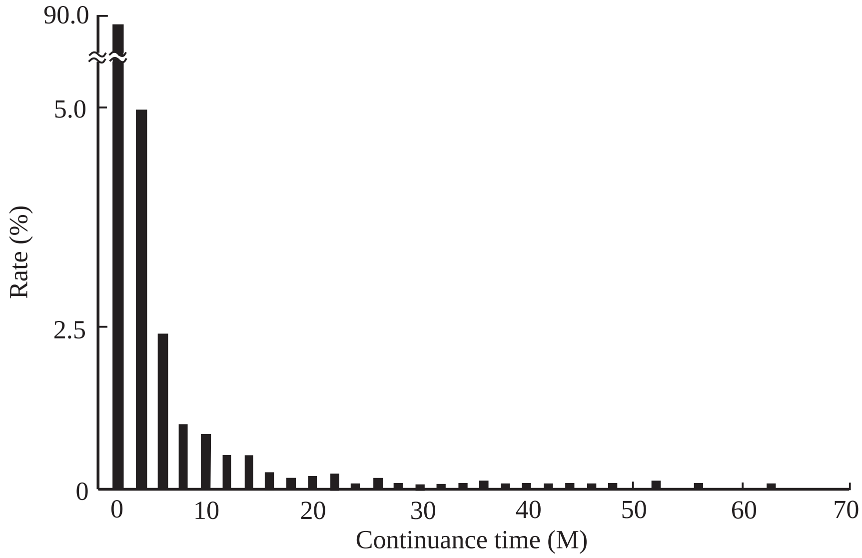


Fig. 3 The frequency distribution histogram for the continuance time of the rest/sleep state.

III. Result and conclusion

The experiments were carried out to record the communication range and the communication time required to transmit the emergency situation via the voice modem. The communication range was recorded in a one-floor concrete apartment dwelling (floor area 126m^2). The ECD was placed in the center part of apartment and the detector was moved to each room. The communication was totally reliable throughout this test. The maximum transmission range is up to 12 m, with the maximum time being ten seconds.

The developed life-safety system is not only very applicable to elderly people living by themselves, but should also be found very useful for monitoring hospital patients and persons in long-term care facilities.

References

[1] Aritomo Mikio, Yonezawa Yoshiharu, and W.Morton Cadwell, "A wrist-mounted activity, sleep, and heart rate recording system," The 1st BMES-EMB joint conference, Proceeding, pp.693, 1999.

[2] Yukio Yoshida, Yoshiharu Yonezawa, Koji Sata, Ishio Ninomiya, W.morton Caldwell, " A werable posture, behavior and activity recording system," World Congress on Medical Physics and Biomedical Engineering, Proceeding, TU-FXH-98, 2000.