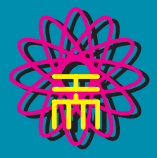

HIROSHIMA INSTITUTE OF TECHNOLOGY

A MICROCOMPUTER-BASED DATA ACQUISITION SYSTEM FOR ECG, BODY AND AMBIENT TEMPERATURES MEASUREMENT DURING BATHING

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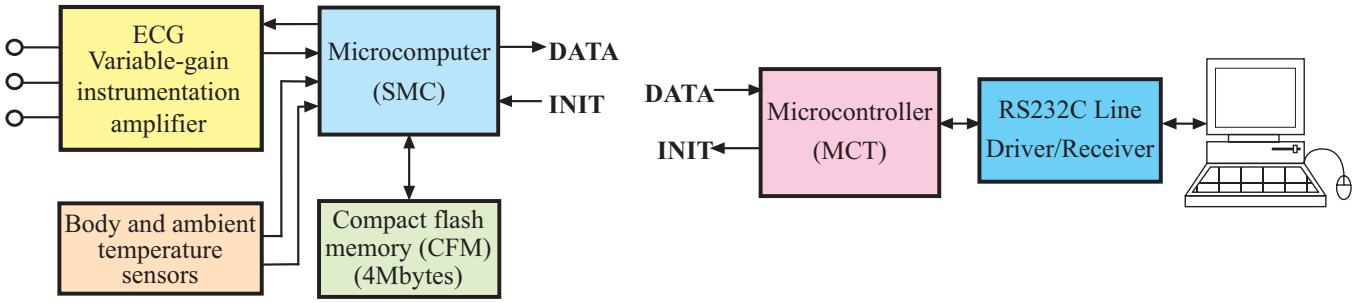
INTRODUCTION

Sudden death of elderly persons during bathing is increasing in Japan. The main causes are cardiopulmonary stop, cerebral vascular accident and drowning. Cardiopulmonary stop due to heavy heart loading from excessive peripheral vasodilation by the hot bath water is the cause of most of these deaths. Therefore, it is very important to record the electrocardiogram (ECG) for obtaining heart rate variability and ECG waveform changes before, during and after bathing so that sudden death preventive techniques can be developed.

A new microcomputer-based data acquisition system, employing an 8-bit microcomputer, a compact flash memory and a very low parts count has been developed to fill the need for continuous recording of body and ambient temperatures and the ECG during the bathing sequence.

This report details the compact, three channel time-multiplexed, digital recording system, which is fastened to the chest by three disposable ECG electrodes.

SYSTEM DESCRIPTION



(a) ECG and temperatures recorder (b)Data terminal adapter

Figure 1. The microcomputer-based data acquisition system. The system consists of an ECG variable-gain instrumentation amplifier, two temperature sensors, a microcontroller (SMC) and a 4 MB compact flash memory(CFM). The ECG, body and ambient temperatures are recorded continuously. Maximum recording time is one hour. After recording these parameters before, during and after bathing, the data are read out by the data terminal adapter, which consists of a microcontroller (MCT), a RS232C line driver/receiver and a personal computer.

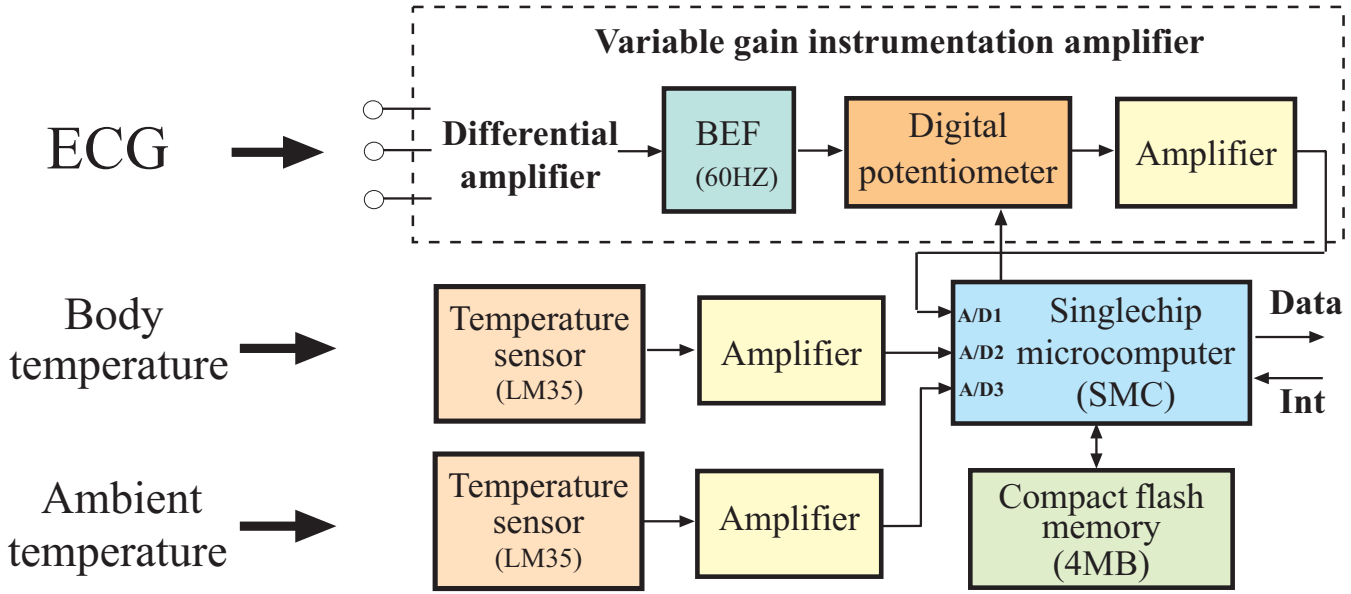


Figure 2. The recorder block diagram. The recorder consists of an ECG variable-gain instrumentation amplifier (VGIA), two temperature sensors, a 60Hz band-elimination filter (BEF), the SMC (NEC, μ PD78P078) and 4 MB CFM. The VGIA is designed with a low-noise, low-power instrumentation amplifier and a digital potentiometer [1]. The amplifier employs a low-noise, low-power instrumentation amplifier and two ultra low-power operational amplifiers. The gain is set by the potentiometer, which is controlled by the SMC. The maximum gain can be set at 60 dB and reduced in 256 steps. The signal bandwidth is 0.1 - 200 Hz. The 60 Hz filter is a twin-T circuit. The temperature sensors are National Semiconductor

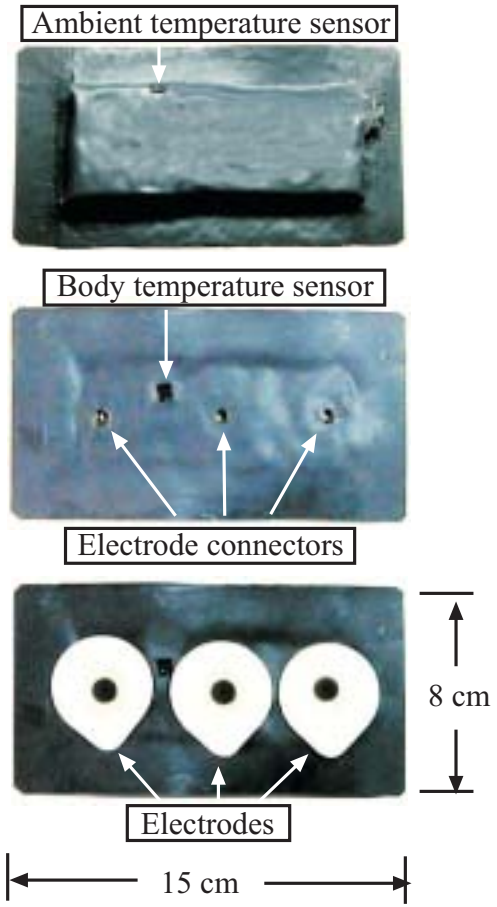


Figure 3. The circuit is constructed on a 35 x 95 mm PC board and encapsulated in epoxy and silicone sheet, yielding a total volume of 44 cc. The weight is 100 grams. The recorder is attached on the center of the chest with three disposable ECG electrodes and fixed tightly by double-sided adhesive tape.

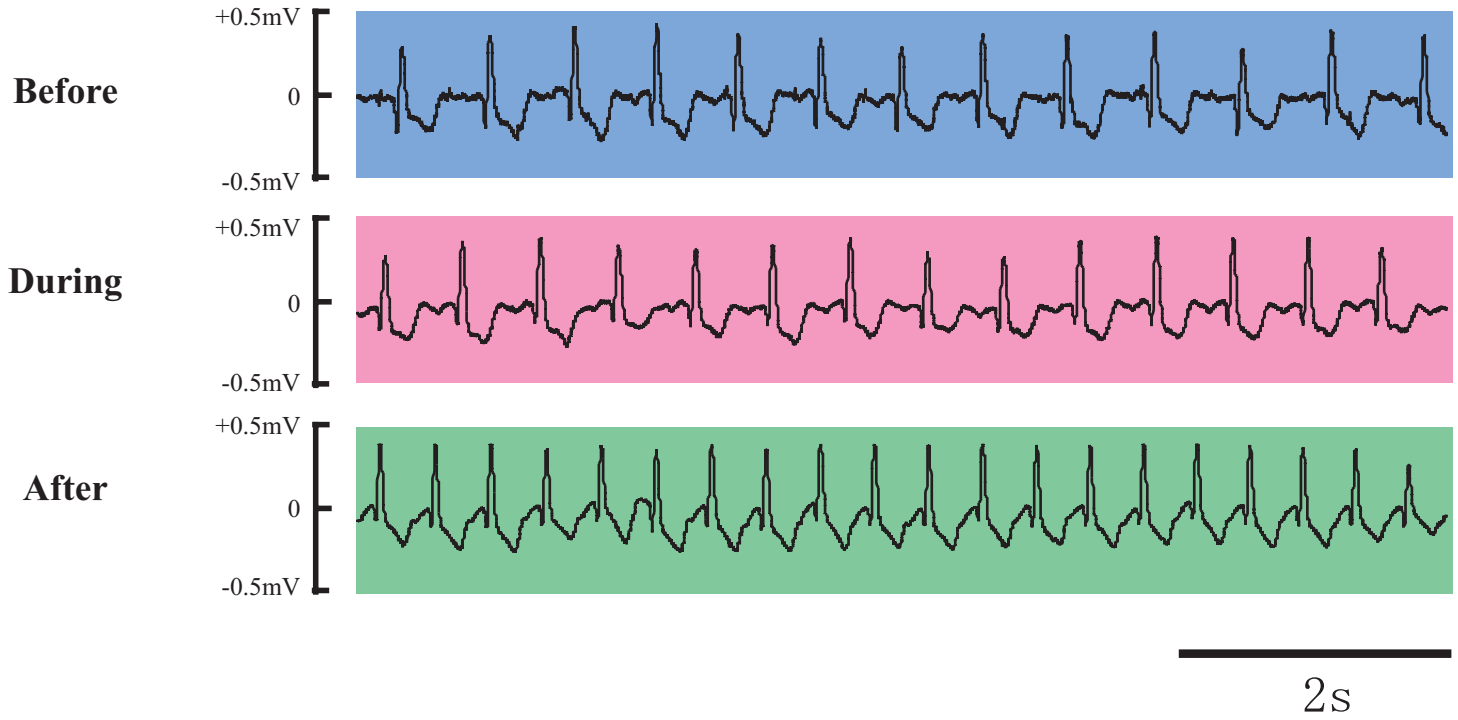


Figure 4. The recorded ECG wave forms before, during and after bathing. The mean RR interval before bathing is 0.57 s. When the subject started the bath, the RR interval changed quickly from 0.57 s to 0.66 s, and then gradually decrease to 0.55 s. At the moment when the subject came out of the bath tub, the RR interval decrease to 0.37 s. After that the RR interval gradually returned to 0.65 s.

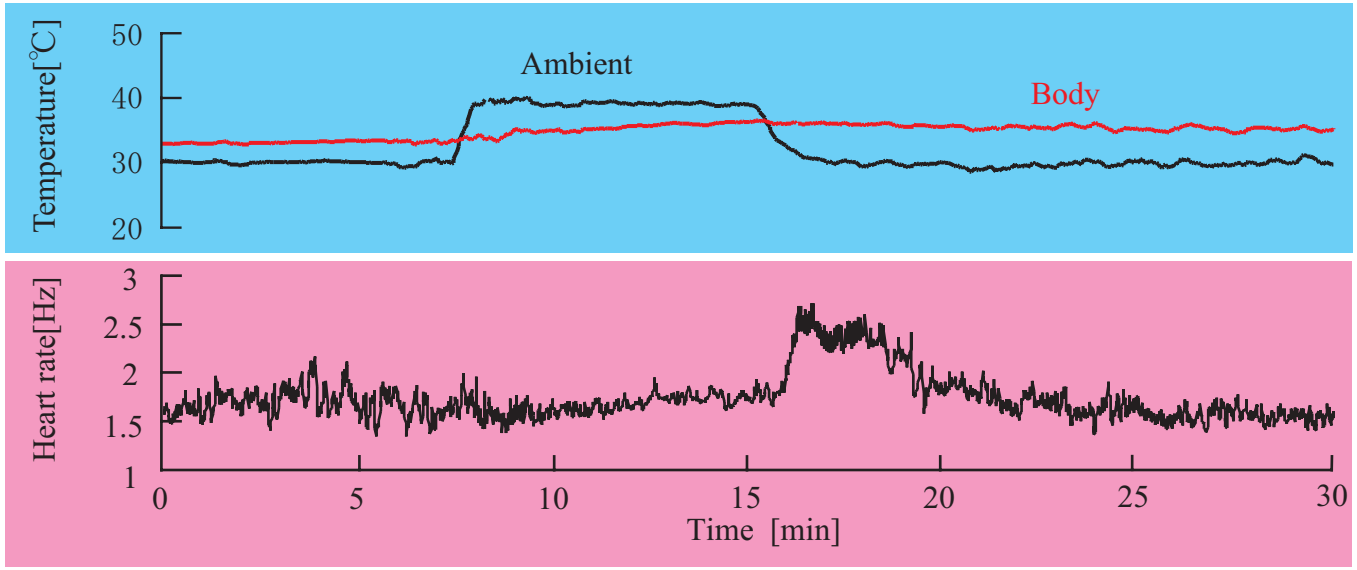


Figure 5. The heart rate, body and ambient temperatures before, during and after bathing. The heart rate is calculated by the RR interval detected from ECG wave form. The data easily identifies the bathing period, as indicated by the ambient temperature. The mean heart rate and skin temperature before bathing were 1.75 Hz and 33 degrees C. When the subject started the bath, the ambient temperature quickly increased from 30 to 40 degrees C. On the other hand, the skin temperature increased gradually to 37 degrees C. The mean heart rate changed quickly from 1.75 Hz to 1.5 Hz, and then gradually increased to 1.8 Hz. At the moment when the subject came out of the bath tub, the heart rate increased to 2.7 Hz. After that the heart rate gradually returned to 1.53 Hz.

CONCLUSION

The data acquisition system employing a low power 8 bit microcomputer has been developed for heart rate variability monitoring before, during and after bathing. The recording system is attached to the patient's chest and the ECG, body and ambient temperatures are recorded during the bathing sequence.

The analysis of the recorded ECG signal enables the finding of prognostic indicators for cardiovascular disease states and may identify persons who are at risk of sudden death during bathing.

REFERENCES

1) Ohnishi J., Yonezawa Y., and Ninomiya I.: A compact electrode-mouted, ECG R-R interval recording system. The 1st joint meeting of BMES & EMBS, Proceeding, pp.293, 1999.