A COMPACT ECG R-R INTERVAL, RESPIRATION AND ACTIVITY RECORDING SYSTEM

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Introduction

It is very important to record the heart rate with respiration and activity for monitoring the patient's cardiovascular regulatory system in daily life.

Purpose

For monitoring variability of heart rate and respiratory frequency during daily life, a new ECG R-R interval, respiration and activity recording system has been developed.

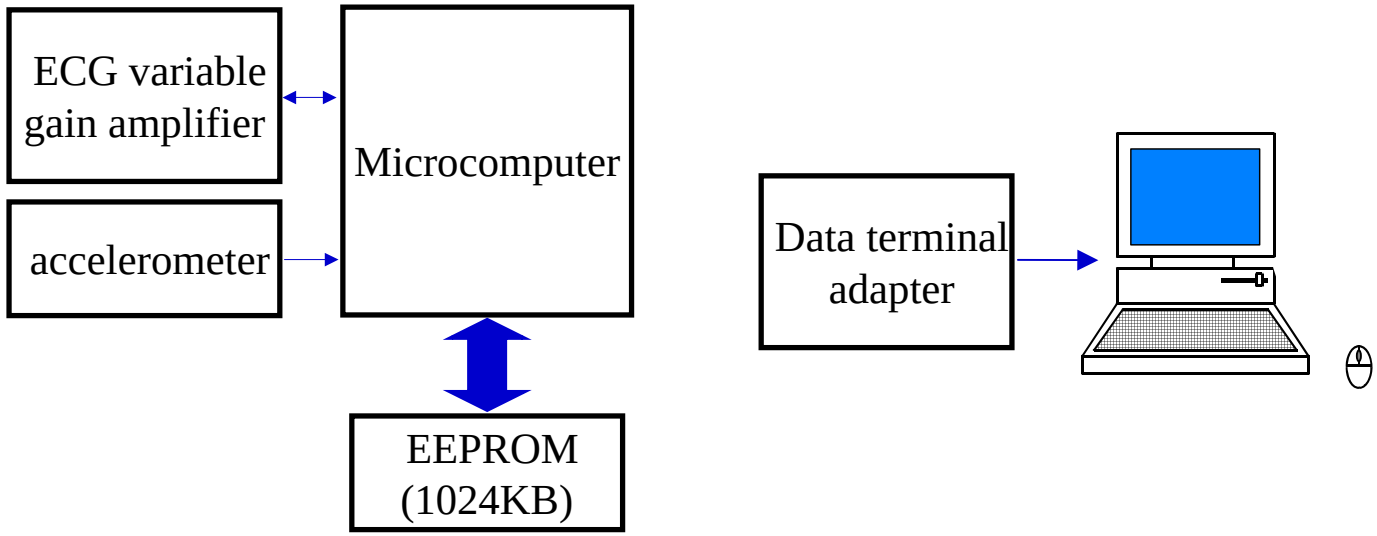

Figure 1. The overall recording system. The recording system consists of a compact, single module, R-R interval, respiration and activity recording device, a data terminal adapter and personal computer (PC). After recording, the data are downloaded to a desktop computer via the data terminal adapter for analysis.

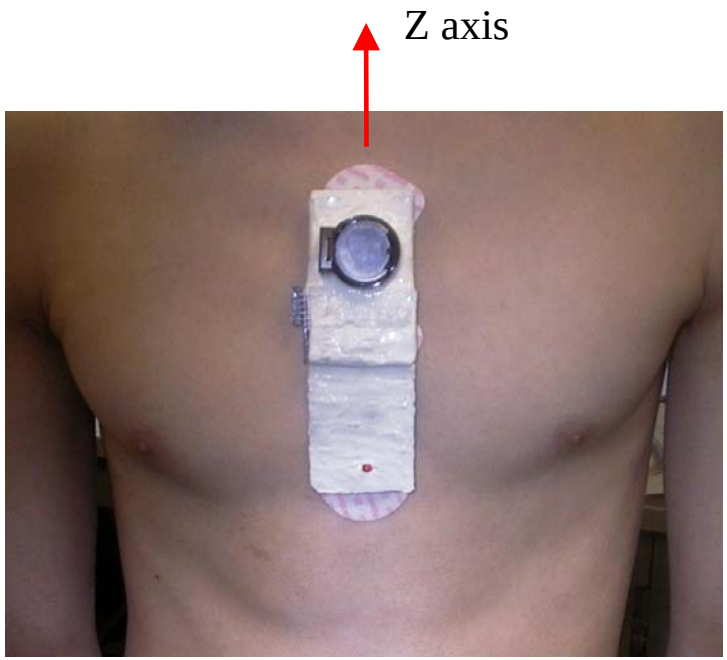

Figure 2. The R-R interval, posture and activity recording device attached on the center of the chest with three disposable ECG electrodes. The device is 5 x 13 cm, the thick is 1 cm and the weight is 30g.

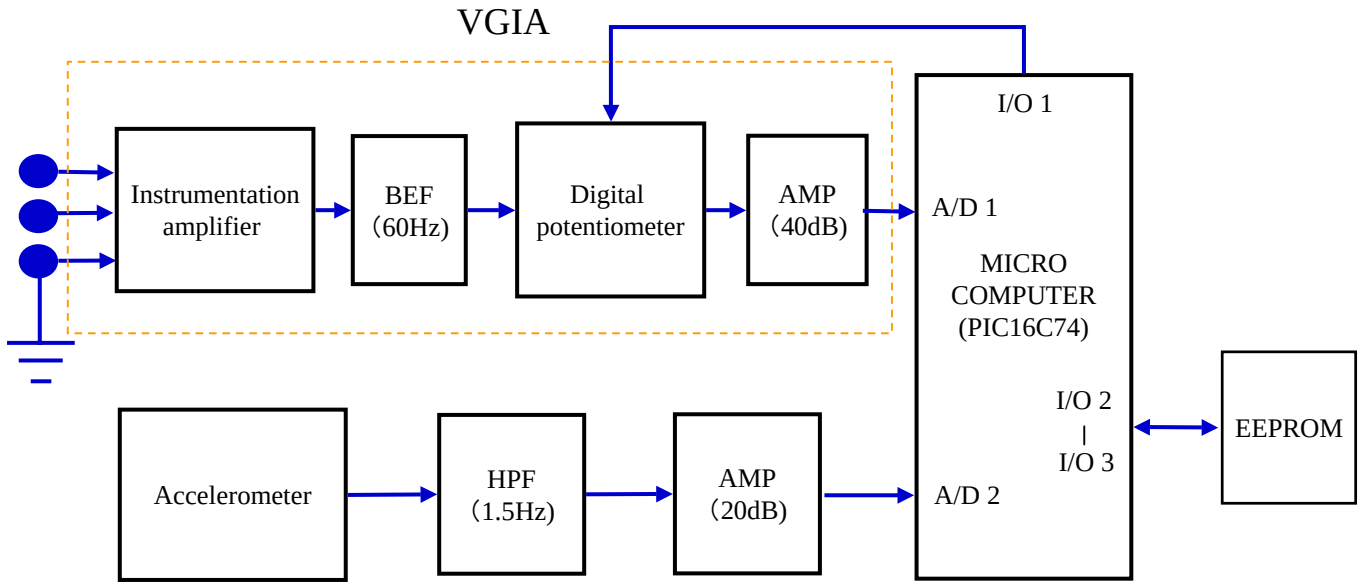

Figure 3. The block diagram of the R-R interval, posture and activity recording device. The VGIA(Variable Gain Instrumentation Amplifier) and accelerometer records ECG and the Z-axis dynamic acceleration force, respectively. The microcomputer detects R-R interval, respiration and activity. These detected data are stored to the EEPROM.

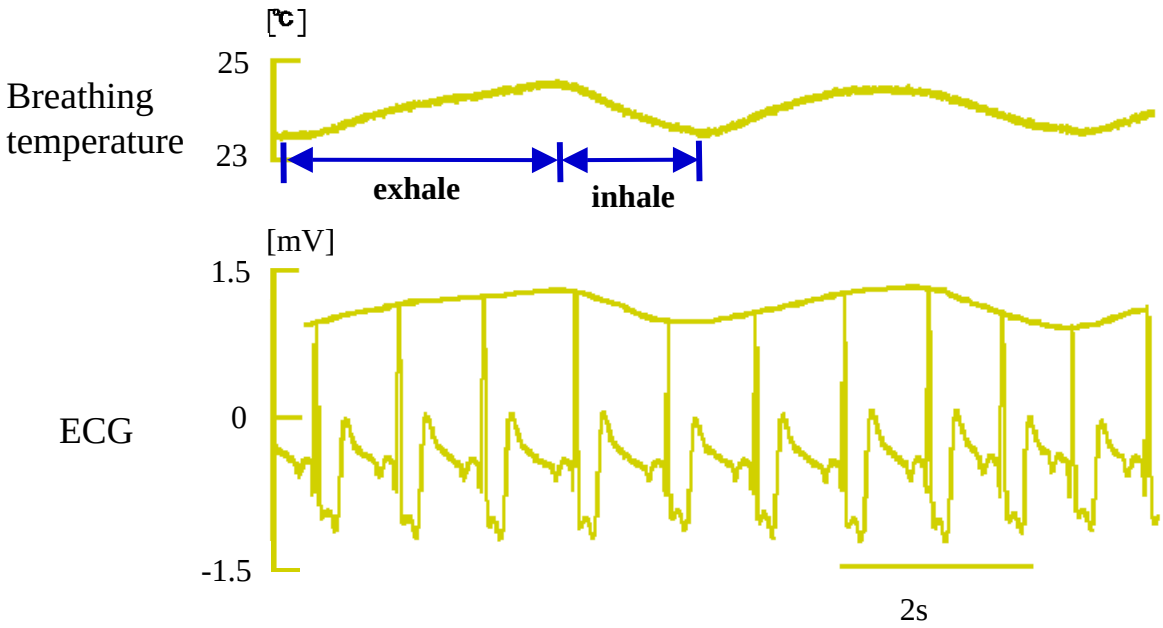

Figure 4. Relationship between the breathing temperature recorded under nose and the envelope of the R wave peak amplitudes

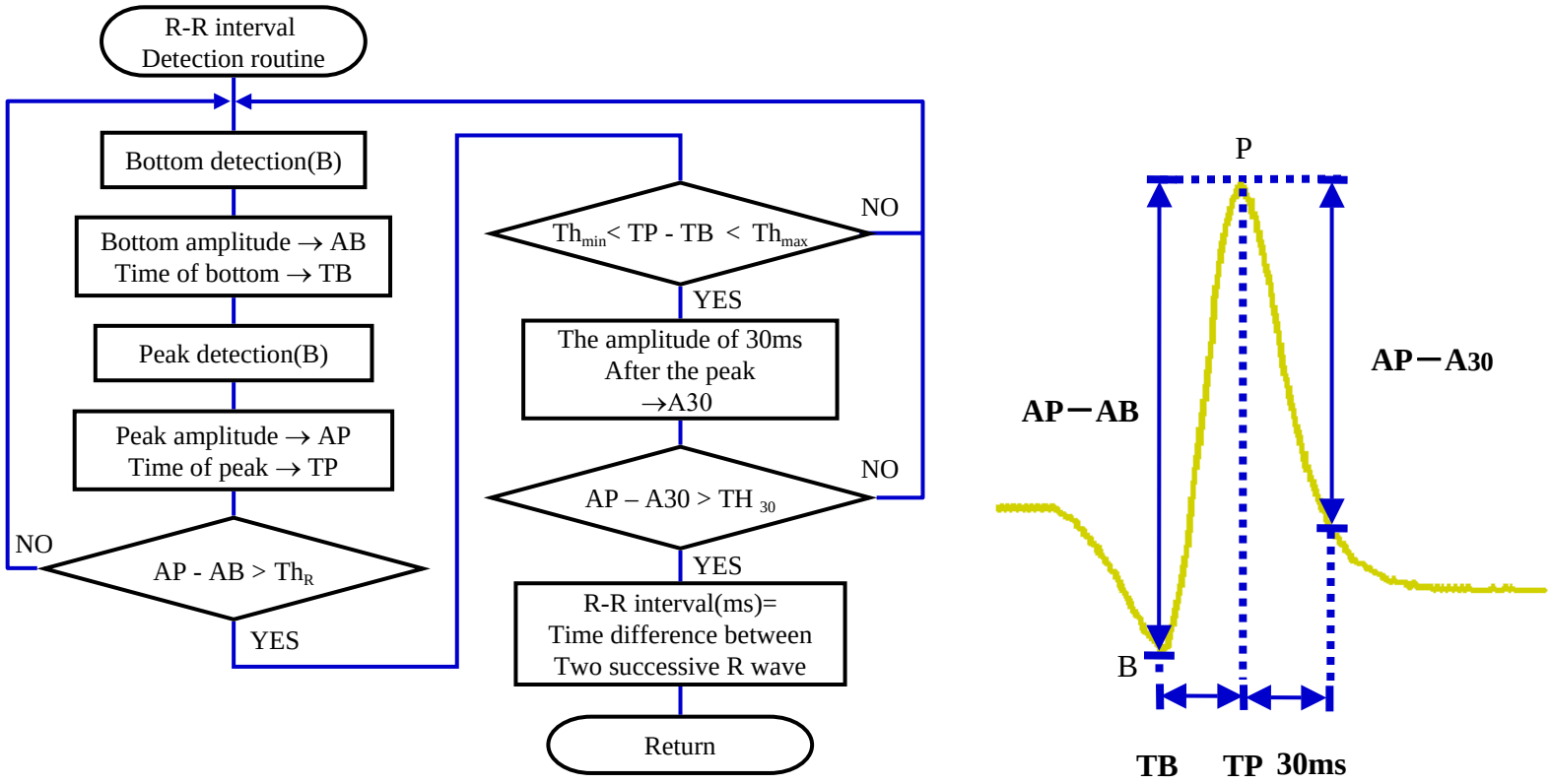

Figure 5. The R wave detection flowchart. The R wave is detected by sequentially comparing the amplitude and duration from the pre-peak nadir to the peak. When condition AP-AB > Th_R and Th_{min}< TPB < Th_{max} are satisfied, the signal is detected as the temporary R wave. When AP-A30 > Th_{30} is satisfied, the temporary R wave is identified as a valid R wave.

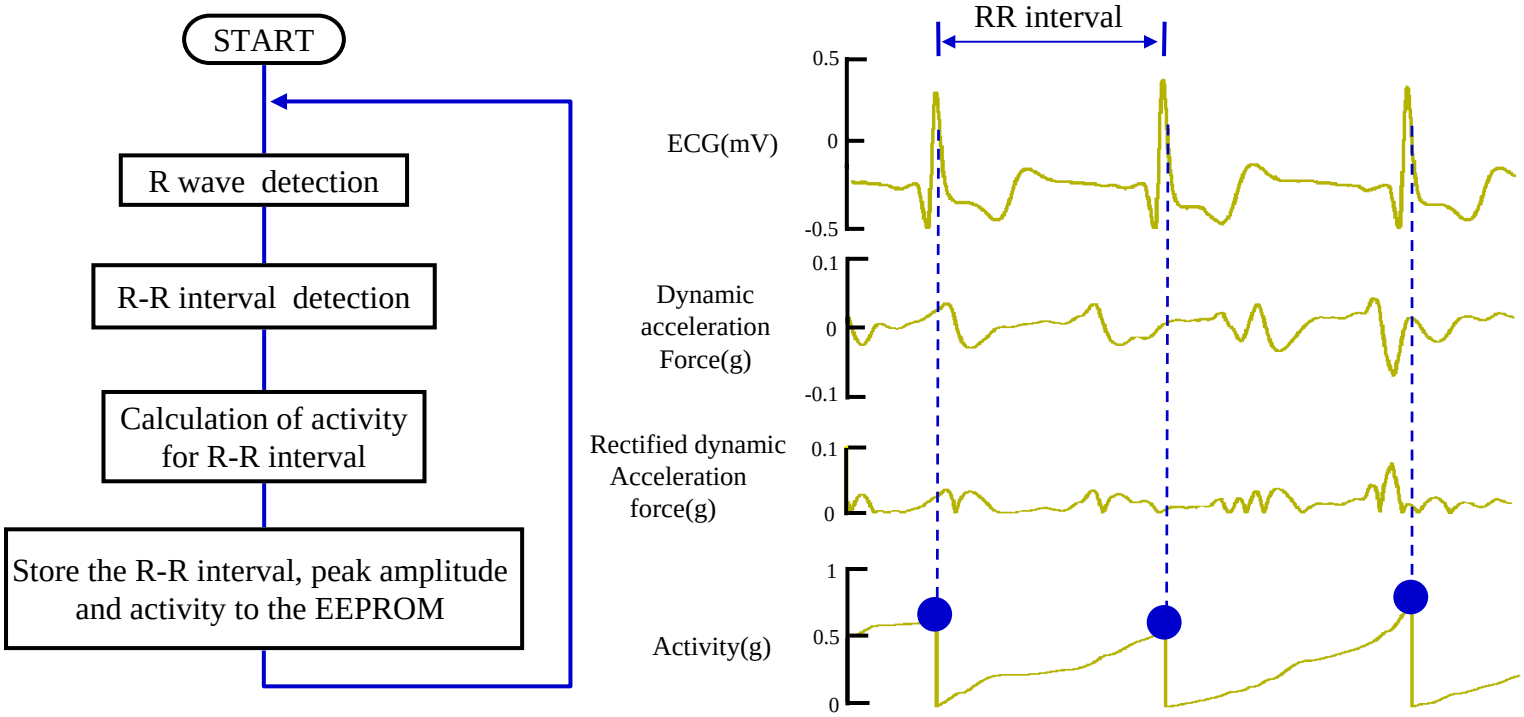

Figure 6. The R-R interval, respiration and activity recording device flowchart. Activity is obtained by adding the dynamic acceleration force for R-R interval

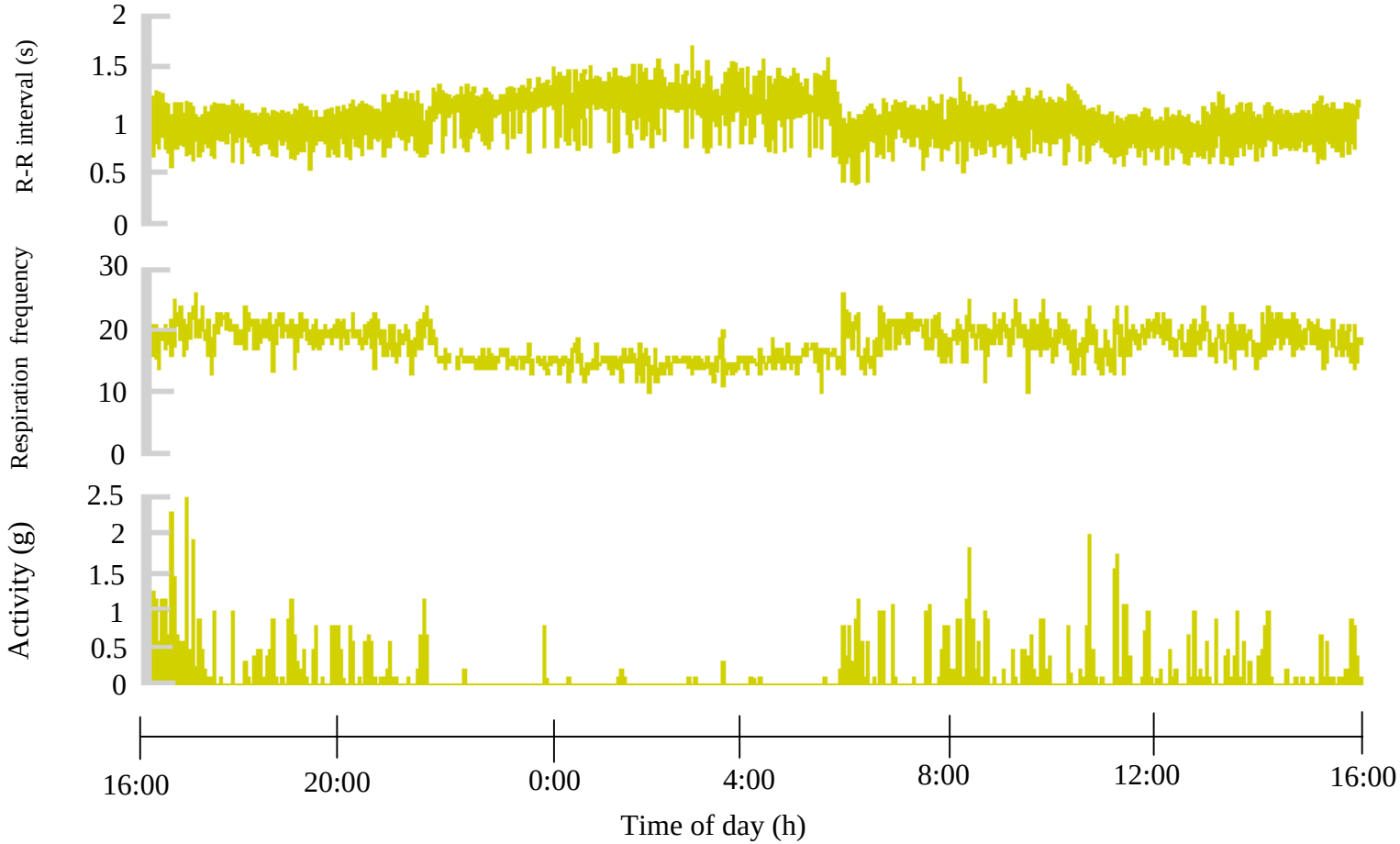

Figure 7. The R-R interval, respiration frequency and activity recorded over 24 hours. The mean R-R interval was approximately 0.9 seconds during wakefulness and increased to 1.3 seconds during the 22:00 to 6:00 sleep period. The frequency of respiration decreased from 20/minute while awake to 15 during sleep. The activity data indicated an extremely low level during sleep.

Conclusion

1) The developed system can precisely record the RR interval, respiration and activity for 3 days.
2) The 36cc and 30 grams recording device is attached directly onto three ECG chest electrodes.
3) The RR interval was obtained in 1 ms resolving time.
4) The system doesn’t need any respiration sensors.
5) The recorded data can be used to detect the subject's general health condition and living patterns in daily life.