HIROSHIMA INSTITUTE OF TECHNOKOGY

A SLEEP APNEA SYNDROME DETECTION SYSTEM

Ryouichi Ishida, Yoshiharu Yonezawa, Hiromichi Maki , Hidekuni Ogawa, Allen W. Hahn and W. Morton Caldwell

(RI) : Department of Electronics, Hiroshima Institute of Technology, Hiroshima 731-5193, Japan.
(HO) : Department of Information & Intellectual Systems, Hiroshima Institute of Technology, Hiroshima 731-5193, Japan
(YY) : Department of Electronics, Hiroshima Institute of Technology, Hiroshima 731-5193, Japan.
(AWH): Department of Veterinary Medicine and Surgery, University of Missouri-Columbia, Missouri 65211.
(HM) : Department of Clinical Engineering, International Trinity College, Hiroshima 730-0014, Japan
(WMC): Caldwell Biomedical Electronics,Hurricane, West Virginia 25526.

INTRODUCTION

Sleep apnea syndrome (SAS) is characterized by interruptions of breathing and disturbs the patient's sleep amount and quality. There are two causes of sleep apnea. One of them is an obstructive sleep apnea, which is closure of the airway by a drop of the tongue root. The other is a central sleep apnea caused neural problems. A diagnostic test of SAS requires an over night stay in hospital. A number of physiologic parameters such as EOG, EEG, EMG, ECG, tracheal noise, nasal and oral airflow, thoracic and abdominal body movements and oxygen saturation are recorded by Polysomnography.

In this study, we have developed a new sleep apnea syndrome detection system employing a piezoelectric sensor. The system detects whether the patient is in SAS from the amplitude and frequency components of the timed thoracic body movement changes.

SYSTEM DESCRIPTION

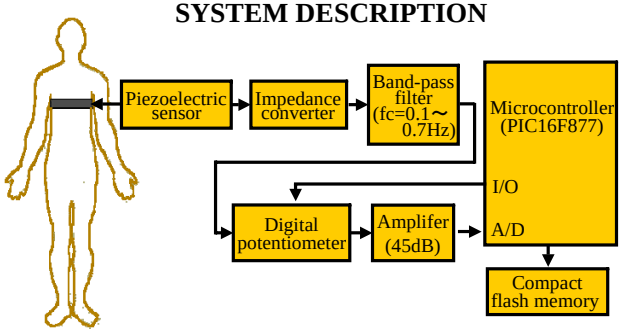

Figure 1 Block diagram of the slow body movements recorder. The recorder employs a piezoelectric sensor (Pennwalt, Kynar Piezo Film), an impedance converter, low-power active filter, an addressable dual digital potentiometer (Texas Instrument, DS1803,), low-power amplifiers, a low-power microcontroller (Microchip Technology, PIC16F877) and a 32MB compact flash memory.

RESULTS

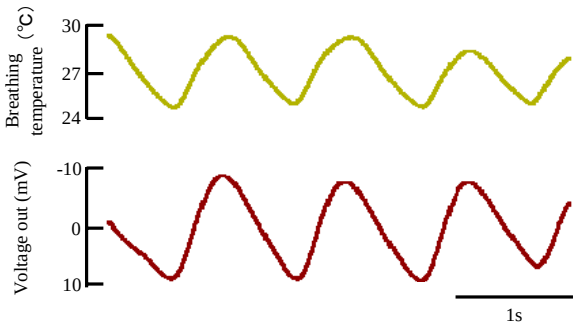

Figure 2 The respiratory waveforms recorded by two methods. The breathing temperature change is recorded with two thermistors attached under the nostril. The thoracic body movement is recorded by the developed recorder. The thoracic body movement is similar to the breathing temperature and has the same period. Therefore, the thoracic body movement recoded by the developed recorder shows a respiration wave.

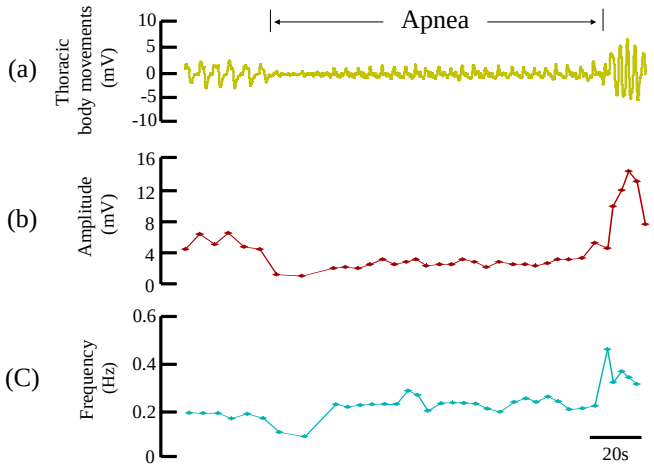

Figure 3 The thoracic body movement (plot a), the peak amplitude of the respiration (plot b) and frequency (plot c) recorded by the developed system. The average peak amplitude and frequency before apnea were 6.5 mV and 0.18Hz. Under apnea, the average peak amplitude decreased to 3.2mV. On the other hand, the frequency increased to 0.25 Hz. After that, both peak amplitude and frequency increased to 14mV and 0.47Hz extremes.

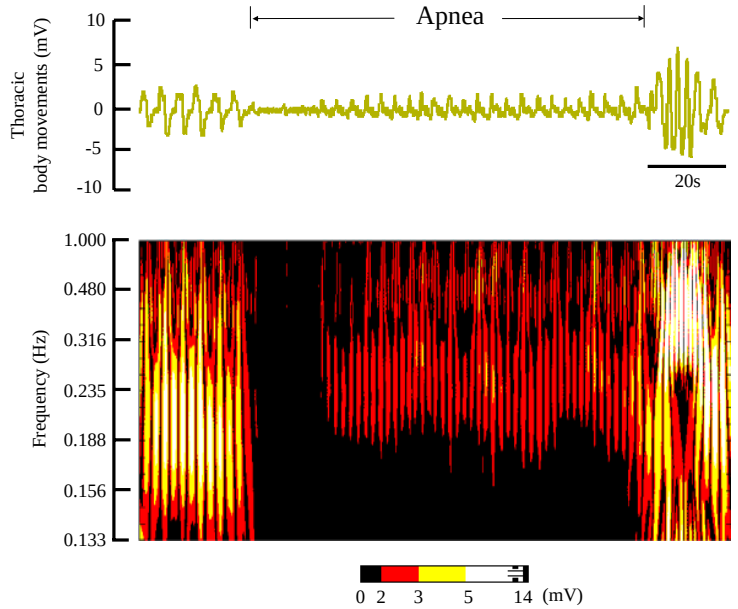

Figure 4 The continuous wavelet transform of the recorded thoracic body movements. The Biorthogonal 3.5 was used for this transform. The amplitudes become higher in the order, black, red, yellow and white colors. The result showed both the peak amplitude and the frequency detected in Figure 3 (b) and (c). Apnea syndrome (SAS) by the wavelet transform can be detected easily.

CONCLUSION

These results indicate that SAS is detected by the amplitude and frequency components of the timed thoracic movement changes. The developed system can be used at home and be self-applied by the patients for monitoring during sleep and the detection of SAS episodes.

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