A Study of Vital Care Monitor Using Bed-Type Respirometer

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Abstract—We proposed an algorithm for detecting respiration cease and constructed a pilot vital care monitor capable of monitoring respiratory variation unobtrusively. Mean detection rate of the algorithm was 85% for three subjects.

I. INTRODUCTION

Aging populations call for pervasive monitoring of vital signs and for early detection of critical health status in the elderly facilities or at home (hereinafter collectively called vital care monitor). Extended system of a non-contact bed-type cardiopulmonary monitor proposed by Ueno et al. [1] is a potential candidate for this vital care monitor. However, a dedicated algorithm for detecting the critical status, such as respiration cease, is necessary because output signal from the cardiopulmonary monitor is slight unstable for the sake of non-contact sensing. In this study, we proposed an algorithm for detecting respiration cease and implemented it in a microcontroller for real time processing. We employed a part of the cardiopulmonary monitor as a bed-type respirometer.

II. MATERIALS AND METHODS

The proposed vital care monitor consists of the bed-type respirometer, a respiration cease detector composed of a microcontroller (Microchip Technology Inc., PIC16F88) where the developed algorithm is installed, a network communication module for telemonitoring (Lantronix, XPort), and a client PC connected to the Internet. Web browser installed in the client PC continuously displays a waveform of respiratory variation send from the communication module.

The respiration cease detector turns on a LED alarm in cases any respiration ceases longer than 10s are detected. The algorithm is based on adaptive thresholds in the time domain. First, the first three cycles of sinusoidal variation after the onset of the measurement is detected by a predetermined reference potential. Secondly, positive amplitudes, negative amplitudes and periods of the cycles are respectively averaged. A value of 50% of the averaged amplitude is set to a primal value of a threshold of $V_{thr}$ for detecting subsequent 10 respiratory variations. Value of $V_{thr}$ is renewed repeatedly after a 10 sequential detection. A value of 33% of the averaged periods is set to a primal value of a threshold of $T_{thr}$ for detecting respiratory cease. Value of $T_{thr}$ is also renewed repeatedly as in the case in $V_{thr}$. In case a session below $V_{thr}$ exceeds $T_{thr}$, the session is considered as a suspected cease of respiration. When the duration of the suspected cease reaches 10s, the session is determined to respiration cease and a trigger signal is sent to the alarm.

Three male subjects, from each of whom an informed consent was obtained, were participated in the experiment for evaluating the proposed algorithm. The subjects lied on a bed where the bed-type respirometer was implemented, and performed spontaneous breathings and 15-second breath-holdings according to the instruction of the experimenter. Reference respiratory variation detected by a commercial band-type respirometer (Biopac system, TSD201) and event trigger signal were simultaneously recorded with the outputs of the bed-type respirometer and the developed respiration cease detector.

III. RESULTS

Time course variation of respiration was observed by a remotely-connected PC. As shown in figure 2, the proposed algorithm could detect respiration ceases corresponding to each event trigger. Mean detection rate for three subjects was 85%. With respect to undetected breath-holdings, shortened duration of suspected cease was observed.

IV. CONCLUSION

In this study, we proposed an algorithm for detecting respiration cease and constructed a pilot vital care monitor capable of monitoring respiratory variation unobtrusively. Mean detection rate of the algorithm was 85% for three subjects. Improvement of the detection algorithm and the stability of the bed-type respirometer were indicated.

REFERENCES