SpO_2 and $PetCO_2$ Signal Analysis in Closed-Loop Mechanical Lung Ventilation Systems

Oleg Bodilovskyi, Anton Popov, Mykhailo Zakorchevnyi

Abstract – **Employment of SpO_2 and $PetCO_2$ signal analysis for setting parameters of mechanical lung ventilation in closed-loop systems is considered. Results of time-frequency representation of such signals are presented and discussed.**

Keywords – **SpO_2 analysis, $PetCO_2$ analysis, closed-loop mechanical lung ventilation.**

I. Introduction

Anesthesiology and intensive care are among the fastest growing and most funded branches of modern medicine. Special attention of researchers from around the world is paid to mechanical (assisted) lung ventilation as the primary mean of support in intensive care and during surgery. As in many areas of modern medicine there is a case when in its development hardware of such systems should be ahead of the existing medical methodology. That's why leading manufacturers of medical equipment made slope on new and sophisticated algorithms and modes of respiratory support. On the top of device range are closed-loop ventilation systems, which automatically set the optimal ventilation regime depending on the patient's vital parameters. However, to date there is no ventilation mode that fully meets the needs of physiological gas exchange in human body. One of the ways to improve current systems is to use a more detailed analysis of signals that describe oxygen and carbon dioxide transport in blood and body tissues.

In this paper SpO_2 and $PetSO_2$ signal analysis block is proposed to be included in mechanical lung ventilation system (Figure 1, [1]). It is intended to calculate signal parameters and feed them back to the control system for estimation of presets and adjusting ventilation mode.

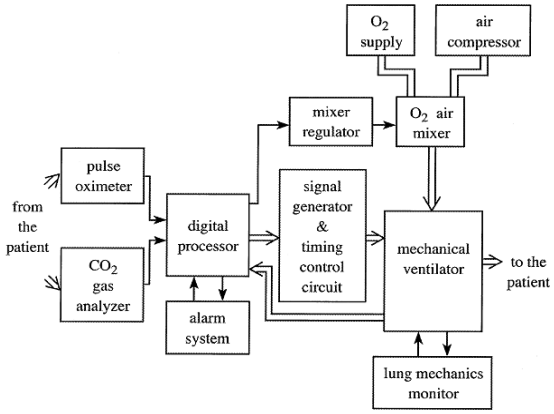

Fig. 1. Closed-loop lung ventilation system [1].

We propose to perform time-frequency analysis of signals that will assess not only SpO_2 and $PetSO_2$ spectral parameters at the moment, but also to assess the dynamics of their previous changes for future ventilation control.

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II. Analysis of SpO_2 and $PetCO_2$ signals

Results of SpO_2 and $PetSO_2$ time-frequency analysis are presented. Signals were obtained from healthy subjects in various breathing modes (slowed breathing, prolonged breathing delay and frequent superficial breathing). After registration with standardized patient monitor (UM-600, Utas Co., Kyiv, Ukraine) the time-spectral representations [2] were obtained in MatLAB with various windows types, lengths and overlapping.

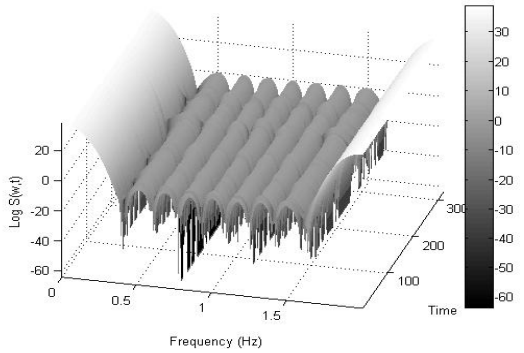

Fig. 2. Example of $PetCO_2$ signal spectrogram

Results showed that time-frequency representation of SpO_2 and $PetCO_2$ has low informativity in describing oscillatory behavior of the signals, and thus this approach is unlikely to be used in control and regulation systems. Choice of window length enough for satisfactory regulation, leads the system to inability to track changes in the signal. This could be due to the nature of signals that change slowly and do not vary by more than 2% (in case of signal for healthy person).

III. Conclusion

Time-frequency analysis of SpO_2 i $PetCO_2$ signals was performed and results for different spectrogram calculation presets were shown in this paper. The first step is done to more sophisticate than usual analysis of breathing dynamics to be employed in closed-loop mechanical lung ventilation systems. We can conclude that time-frequency representation of SpO_2 and $PetCO_2$ signals has low efficiency and are not useful for deriving oxygen and carbon dioxide rates changes for automated adjusting of mechanical ventilation parameters.

References

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