Modeling lung functionality in volume-controlled ventilation for critical care patients

Al-Hetari, Husam Y.[a, b]; Alginahi, Yasser[c]; Kabir, Muhammad Nomani[a]; Al-Naggar, Noman Q.[b]; Al-Rumaima, Mahmoud A.[b]; Hasan, Md Munirul[a]

[a] University Malaysia Pahang, Malaysia, Faculty of Computing, Gambang, Kuantan, 26300, Malaysia

[b] Dept. of Biomedical Engineering, Faculty of Engineering, University of Science and Technology, Yemen

[c] University of Windsor, Dept. of Electrical and Computer Engineering, 401 Sunset Ave, Windsor, N9B 3P4, ON, Canada

ABSTRACT

Mechanical ventilators are the instruments that assist breathing of the patients having respiratory diseases e.g., pneumonia and coronavirus disease 2019 (COVID-19). This paper presents a modified lung model under volume-controlled ventilation to describe the lung volume and air flow in terms of air pressure signal from the ventilator. A negative feedback is incorporated in the model to balance the lung volume that is influenced by a lung parameter called positive end expiration pressure. We partially solved the lung model equation which takes the form of a first-order differential equation and then unknown parameters associated with the model were computed using a nonlinear least-squares method. Experimental data required for parameter identification and validation of the lung model were obtained by running a volume-controlled ventilator connected to a reference device and an artificial lung. The proposed model considering negative feedback achieves a better accuracy than that without feedback as demonstrated by test results. The developed model can be used in intensive care units (ICU) to evaluate mechanical ventilation performance and lung functionality in real-time.

KEYWORDS

COVID-19; Critical care; Lung model; Mechanical ventilation; Volume-controlled ventilation

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