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| **Title:** | Design and Performance Evaluation of a Low-Cost Non-Invasive Electromechanical Ventilator With Feedback Mechanism | | |
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| **Abstract:** |  |
| Non-invasive ventilators (NIV) are widely utilized in managing both acute and chronic respiratory failure. Operating by delivering oxygenated air into the lungs through positive air pressure, they demand vigilant supervision and adjustment to prevent complications. Key challenges in NIV advancement include enhancing patient-device synchrony, monitoring capabilities, portability, affordability, and user-friendly operation with diverse modes to improve patient adherence. This study introduces an innovative non-invasive electromechanical ventilator that autonomously adjusts based on two types of real-time biofeedback data, providing respiratory support to individual patient needs. The system monitors two vital biofeedback signals—oxygen saturation (SpO2) and respiratory rate (RR)—to determine the optimal breathing mode and ceases operation once the patient’s vitals reach a safe range. To acquire biofeedback parameters, a MATLAB simulation model incorporating discrete wavelet transform was designed to extract RR from real-time photoplethysmography (PPG) signals. Comparing hardware-generated results with the simulation outputs yields a mean absolute percentage error (MAPE) of under 10%. Further analyses using Box-whisker and Bland-Altman methods demonstrate significant agreement between measured and simulated RR, particularly among younger demographics. This ventilator system achieves an average accuracy of more than 80% in delivering appropriate breathing patterns based on patient biofeedback. Designed for both home and clinic use, this portable ventilator provides relief from respiratory distress with an intuitive control interface that requires minimal medical expertise. | |