Development and Evaluation of Novel Mechatronic Tracheostomy Tube for Automated Tracheal Suctioning

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PROJECT DESCRIPTION:

Motivation & Objectives

Mechanical ventilation is required to aid patients with breathing difficulty to breathe more comfortably. A tracheostomy tube inserted through an opening in the patient neck into the trachea is connected to a ventilator for suctioning. Currently, nurses spend millions of person-hours yearly to perform this task. To save significant person-hours, an automated mechatronic tracheostomy system is needed. This system allows for relieving nurses and other carers from the millions of person-hours spent yearly on tracheal suctioning. In addition, it will result in huge healthcare cost savings.

Methodology

We introduce a novel mechatronic tracheostomy system including the development of a long suction catheter, automatic suctioning mechanisms, and relevant control approaches to perform tracheal suctioning automatically (See Fig. 1). To stop the catheter at a desired position, two approaches are introduced: (i) Based on the known travel length of catheter tip; (ii) Based on a new sensing device integrated at the catheter tip. It is known that backlash nonlinearity between the suction catheter and its conduit as well as in the gear system of the actuator is unavoidable. They cause difficulties to control the exact position of catheter tip. For the former case, we develop an approximate model of backlash and a direct inverse scheme to enhance the system performances. The scheme does not require any complex inversions of backlash model and allows easy implementations. For the latter, a new sensing device integrated into the suction catheter tip is developed and backlash compensation controls are avoided.

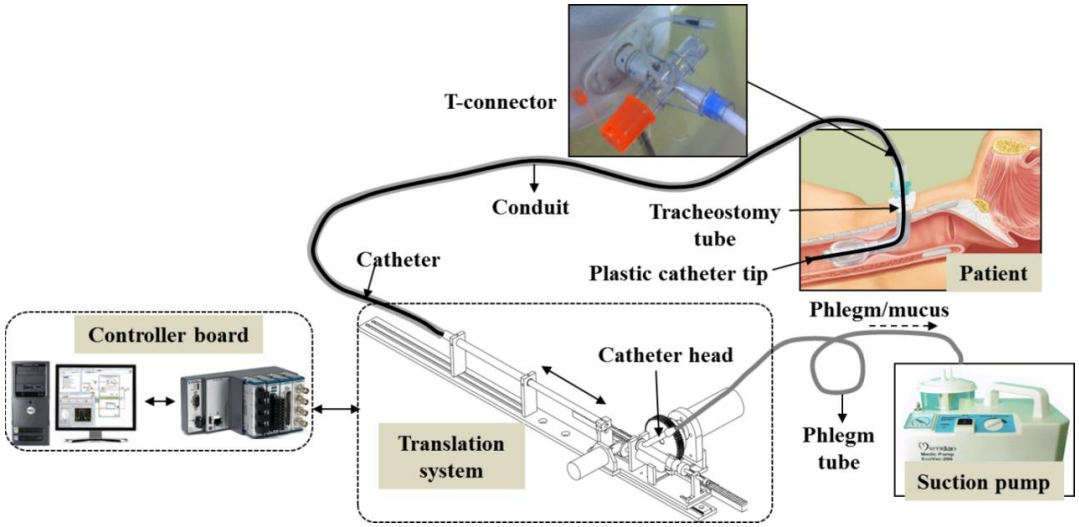

Figure 1: Illustration of the proposed automated mechatronic tracheostomy tube

Results

A novel design for a mechatronic tracheostomy system which incorporates a translation gear system, a new robotic catheter, an electronic suction pump, a tracheostomy tube, a new sensing device, and a real-time controller for automated tracheal suctioning is developed (See Fig. 2). Automated suctioning validations are successfully carried out on the proposed experimental system. Comparisons and discussions are also introduced. The results demonstrate a significant contribution and potential benefits to the mechanical ventilation areas.

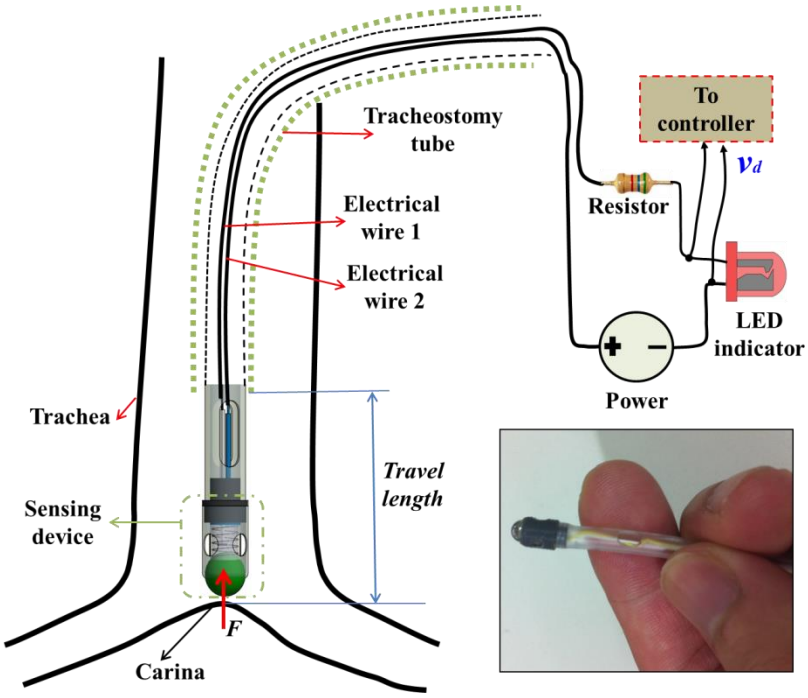

Figure 2: Suction catheter with sensing device inserted to a tracheostomy tube

GRANT:

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PUBLICATIONS:

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[1] T. N. Do, T.E.T. Seah, S. J. Phee, "**Design and Control of a Mechatronic Tracheostomy Tube for Automated Tracheal Suctioning**", *IEEE Trans on Biomedical Engineering*, 2015, DOI: 10.1109/TBME.2015.2491327

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[1] T. N. Do, T.E.T. Seah, S. J. Phee, "**Design and Control of a Novel Mechatronic Tracheostomy Tube-Inserted Suction Catheter for Automated Tracheal Suctioning***", the 7th IEEE International Conference on Cybernetics and Intelligent Systems (CIS) and the 7th IEEE International Conference on Robotics, Automation and Mechatronics (RAM) (CIS-RAM), Angkor Wat, Cambodia*, 2015, pp. 228-233