Voice Prosthesis Integrated Testing System (VPITS)

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Abstract
The Voice Prosthesis Integrated Testing System (VPITS) was created to advance Helix Medical’s research and development to a new state of the art. The VPITS allows testing the aerodynamic properties of two Helix products simultaneously: The voice prosthesis and adjustable tracheostoma valve (ATSV). A voice prosthesis is used to allow airflow from the trachea to the esophagus, this allows speech in Laryngectomy Patients who no longer have vocal cords. The ATSV automatically blocks the stoma in a patients neck to allow hands free speech. A system that tests both devices concurrently has never been created; our new system also incorporates an advanced LabView control that surpasses current testing methods.

Introduction
In the United States there are 3,000 Laryngectomy procedures/year. This market deserves the most advanced product possible. In September 2007, our group was given the task to improve the testing system used by Helix Medical LLC to test their voice prosthesis and ATSV. Currently Helix is able to test the aerodynamic properties of each device separately. However, in human anatomy the two devices are used as a system to allow a laryngectomy patient to speak. To create a more physiologically correct test, that will allow for greater R&D efficiency, we decided to create a fixture that would allow us to test both devices as a single system.

Anatomy and Physiology
After laryngectomy, a patient loses his/her vocal cords making it impossible to speak in the standard way. To remedy this a voice prosthesis is inserted to reroute air from the trachea to the esophagus. This allows voice to be created through the vibration of the esophagus.

Design
System design focused on integrating existing features already tested at Helix Medical, into a single testing apparatus that better represents the human anatomy. To this end we used simulations in COMSOL, tests in LabView, and physical tests with lab equipment.

Design Objectives:
1. Fixture to hold VP and ATSV
2. Controlled air delivery
3. Data acquisition
4. Esophageal pressure system

Figure 4 shows in block diagram form how the system evolved into an integrated testing system from Helix’s testing system.

Control System Design
VPITS and ATSV Testing Modes
Stage 1: Ramp air flow from 0 L/min until trigger pressure is reached.
Stage 2: Implement PID Controller and control to desired pressure.

Voice Prosthesis Testing Mode
Stage 1: Ramp air flow from 0 L/min up to 15 L/min
Stage 2: Ramp air flow from 15 L/min to 0 L/min

Conclusion
The VPITS system met the design requirements set by Helix Medical. The system allows simple analysis completely controlled by LabView. Within Combined System Testing Mode the system allows for never before seen data to be collected. It is hoped that with the VPITS system implemented at Helix’s R&D Lab many new advances may be made.

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References


Figure 1. (A) Patient anatomy (B) Block diagram showing patient voicing process

Figure 2. (A) Voice Prosthesis (B) ATSV

Figure 3. The final Voice Prosthesis Integrated Testing System (VPITS)

Figure 4. (A) Block diagram of Helix’s test system (B) Block diagram of VPITS

Figure 5. Basic PID Control Block Diagram Used