Patient Powered Device for the Treatment of Obstructive Sleep Apnea

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Obstructive sleep apnea is a common sleep disorder in which throat muscles relax during sleep, causing the upper airway to close. As a result, breathing ceases until a brief awakening restores the muscle tone and reopens the airway. Untreated sleep apnea contributes to cognitive, cardiovascular, and metabolic morbidity and has substantial negative impact on an individual's quality of life. Treatment most commonly consists of nightly use of a nasal mask connected to a continuous positive airway pressure (CPAP) machine. The CPAP machine splints the upper airway open by supplying positive air pressure. However, the machine is expensive, requires electricity, and has suboptimal portability, noise, and aesthetics. The aim of this work was to develop a low-cost, lightweight, quiet, and mechanical CPAP machine that would function without an external energy source in resource-limited settings.

Handheld Force Controlled Ultrasound Probe

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An actuated handheld force-feedback controlled ultrasound probe has been developed. The controller maintains a prescribed contact force between the probe and a patient's body. The device will enhance the diagnostic capability of free-hand elastography, swept-force compound imaging and make it easier for a technician to acquire repeatable (i.e., directly comparable) images over time. The mechanical system consists of an ultrasound probe, a ball-screw-driven linear actuator, and a force/torque sensor. The feedback controller commands the motor to rotate the ball screw to translate the ultrasound probe in order to maintain a desired contact force. In preliminary user studies, it was found that the control system maintained a constant contact force with 1.7 times less variation than human subjects provided with a visual force display. Users without a visual force display were only able to maintain a constant force with 20 times worse variation than the automatic controller. The system was also used to determine the viscoelastic properties of soft tissues.