A Hybrid Physical-Virtual Reality Simulation System to Enhance Training of Peripheral Anesthesia

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Technology description

BackgroundThe general field of this invention is simulation-based training (SBT) for medical procedures. SBT has had a major positive impact on safety and operational costs in high-risk industries including aviation, aerospace and the military, and is now being applied to achieve similar benefits in healthcare. SBT is undergoing exponential growth in healthcare as the medical community recognizes its many demonstrated benefits: safe rehearsal of procedures without risk exposure to patients, the ability to provide standardized training and objective assessment, and the ultimate positive effect on patient safety, efficacy of care and reduction of risk exposure.
TechnologyThe current invention is a novel system intended to improve training of peripheral nerve block. Interest in peripheral nerve blockade has increased dramatically in the past decade as it has been recognized that the procedure offers significant benefits in orthopedics and other applications. However, nerve blockade is also potentially harmful. Central nervous system and cardiovascular toxicity, including refractory cardiac arrest, are possible, albeit rare, complications of peripheral nerve blockade. Nerve injury, while usually temporary, is much more common, and studies have estimated its occurrence in 0.3% to 3% of peripheral blocks. The system described herein provides a comprehensive simulator for multiple aspects of various nerve block techniques, including both traditional neurostimulator-guided blocks and newer ultrasound-guided techniques. The key innovation of the current work is a unique approach that combines both real (physical) and virtual models. These models interact with one another and allow accurate, extensible and comprehensive simulation of all salient aspects of the nerve block procedure. This approach and the fundamental technology of the system is applicable to training a wide variety of other medical procedure beyond nerve blockade, including needle biopsy (such as of the breast or liver), lumbar puncture, and brachytherapy (radioactive seed placement) for prostate cancer.

Advantages

Current system combines: (1) a highly accurate physical anatomic model fitted with robotic actuators, (2) a virtual-reality model that provides detailed internal anatomic structural data, (3) a 3D spatial

tracking system for the block needle and ultrasound probe with algorithms to quantify needle and probe targeting accuracy and trajectories, (4) an electronic interface and algorithms enabling use of a real neurostimulator with the system, and (5) a mechatronic system that generates various behaviors at the injection syringe, such as variable resistance to fluid flow and the ability to pull-back either blood simulant or clear fluid depending on needle tip location within the virtual model.

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