Multi-Modal Haptic Feedback System
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SUMMARY
UCLA researchers in the Department of Bioengineering have developed multi-modal haptic feedback systems that are able to simulate the synergistic relationship between the various feedback modalities involved in real human touch. These multi-modal haptic feedback systems hold the promise of eliminating long-standing problem and helping expand the application of robotics in surgical sciences.

BACKGROUND
Robotic minimally invasive surgery (RMIS) was introduced to help eliminate some of the outstanding challenges by providing improvements such as enhanced 3D vision and additional degrees of freedom. Despite obvious advantages, these systems suffer from lack of a comprehensive haptic feedback. This limitation combined with the ability of the robot to generate strong forces at the tip of laparoscopic instruments may result in exertion of excessive force, often leading to tissue scarring and excessive suture breakage.

Intraoperative suture failures can be costly as they result in surgical delays, while postoperative failures could require revisions or create major complications for the patient. The growing popularity of RMIS as an option for minimally invasive gastrointestinal procedures, requiring great amounts of intracorporeal suturing and knot tying, has resulted in higher incidence of suture failures. Therefore, the loss feedback in robotic surgery demands for the development of haptic feedback systems that can provide an artificial sense of touch.

INNOVATION
Researchers at UCLA have developed multi-modal haptic feedback systems (HFSs) that are capable of providing benefits for many different robotic surgical applications. Having inherited an existing tactile feedback system designed for reducing crush injuries in robotic surgical procedures, multi-modal HFSs integrate additional modalities of feedback including kinesthetic force feedback, vibration feedback, and various critical enhancements for pneumatic normal force tactile feedback. Design of a highly configurable software architecture allowed the application of the multi-modal HFS in several different RMIS applications. The multi-modal HFSs not only improves upon the previously developed unimodal tactile feedback systems with regards to reduction of grip force in RMIS, improvements to the sensing technology such as design of shear sensing mechanisms also helps expand the application of haptics beyond grip force reduction.

APPLICATIONS
- Various applications involving robotic surgical systems
- Help improve detection of non-compressible structures such as tumors and vessels in soft tissue phantoms

ADVANTAGES
- Integration of both tactile and kinesthetic force feedback in the same system
- Provide comprehensive haptic feedback and artificial sense of real human touch

STATE OF DEVELOPMENT
Evaluation of the system for knot tying in robotic surgery showed significant benefits in reducing suture breakage and improving knot quality.

PATENT STATUS
Patent Pending