Visual Haptic Feedback for Training of Robotic Suturing

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Current surgical robotic systems are teleoperated and do not have force feedback. Considerable practice is required to learn how to use visual input such as tissue deformation upon contact as a substitute for tactile sense. Thus, unnecessarily high forces are observed in novices, prior to specific robotic training, and visual force feedback studies demonstrated reduction of applied forces. Simulation exercises with realistic suturing tasks can provide training outside the operating room. This paper presents contributions to realistic interactive suture simulation for training of suturing and knot-tying tasks commonly used in robotically-assisted surgery. To improve the realism of the simulation, we developed a global coordinate wire model with a new constraint development for the elongation. We demonstrated that a continuous modeling of the contacts avoids instabilities during knot tightening. Visual cues are additionally provided, based on the computation of mechanical forces or constraints, to support learning how to dose the forces. The results are integrated into a powerful system-agnostic simulator, and the comparison with equivalent tasks performed with the da Vinci Xi system confirms its realism.

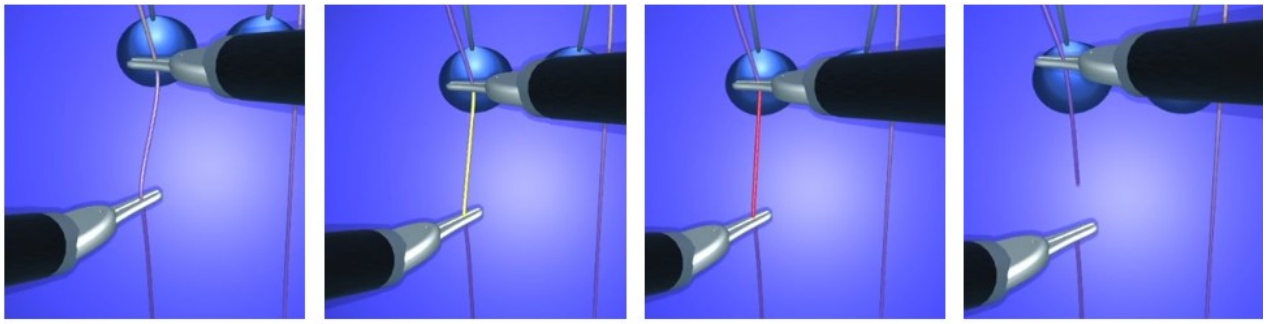

Figure 1: Visual stress on a thread from floppy (A) to tight (B, C) condition until suture breakage with tension release (D).

Joint work with: François Jourdes, Jérémie Allard, Christian Duriez and Barbara Seeliger.

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