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Research In-Progress

A Hierarchical Learning Framework for Designing Robotic Surgical Simulation Content

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Introduction: Attaining proficiency in robotic surgery requires mastery of the technical skills offered by the robotic surgical system. To facilitate standardized training and education of essential robotic surgical skills, we have devised a simulation learning framework.

Methods: The Hierarchical Learning Framework (HLF) is designed with intent to ensure that users can safely, consistently, and competently perform robotic skills using robotic systems. The HLF comprises five tiers, each introducing a new category of metrics: the Interactive Tutorial tier focuses on teaching, the Enabling Objectives (EO) tier emphasizes safety, the Terminal Objectives (TO) tier incorporates efficiency, the Technical Task (TT) tier adds workflow metrics, and the Clinical Task (CT) tier integrates clinical features. The EO and TO tiers concentrate on basic technical skills with well-defined learning objectives. These repetition-based exercises, with graduated skill variation and increasing difficulty, aim to build muscle memory, confidence, and systematically develop competency. The TT tier involves clinically-inspired tasks focused on surgical workflow and techniques. The CT tier requires that users apply technical skills from the previous tiers within a simulated surgical setting, including addressing error recovery situations.

Preliminary Results: We applied the HLF to the Da Vinci SimNow (robotic surgery simulator). The first three TO/EO verticals consist of Basic System Control, Clutching, and Camera Control. TO1 - Basic System Control includes four EOs: Fine Motion Control, Wrist Articulation, Pick and Place, and Bimanual Transfer. Competency in TO1 would denote proficiency in the four underlying EOs. Similarly, TT1 - Create and Maintain Optimal View of Tissue requires the proficiency and application of the underlying TOs/EOs skills. The hierarchical tiers between content and skills within the HLF facilitate the precise tracking of user learning, progress and the development of tailored training curricula.

Next Steps: Future work to validate and assess the impact of this system on surgical education and outcomes.

