Analysis of Individual Differences in Surgical Skill Learning with AI Techniques

Project description:

Surgical training is a comprehensive process that combines theoretical learning, practical experience, and mentorship to prepare medical professionals for performing safe and effective surgical procedures. It ensures patient safety, improves outcomes, and drives innovation by equipping surgeons with essential skills and fostering the adoption of advanced techniques.

Surgical motor skill learning is a critical component of surgical training, involving the development of precise hand movements, coordination, and muscle memory essential for performing procedures safely and effectively. Through repetitive practice, simulation-based training, and supervised experience, surgeons refine their technical proficiency and adaptability to new techniques.

However, individual differences in surgeons' surgical operations (variations in techniques, decision making, hand movements, and efficiency influenced by factors such as experience, physical attributes, and cognitive strategies) pose challenges. These differences can complicate the extraction of standardized surgical motor skills for training novices, as unique styles or adaptations may not always align with universally optimal practices. While these variations offer valuable insights into diverse approaches, they can also lead to inconsistencies in teaching and simulation design.

This internship project aims to analyze the influence of individual differences to surgical skill modeling, by identifying common effective patterns and tailoring training to emphasize fundamental principles while allowing for flexibility ensures that novices acquire the core skills needed for safe and adaptable practice. The project study will involve conducting simple surgical training tasks based on the Simball Box® trainer (as in the figure), collecting multimodal sensor information from the participants, analyzing the essential motion patterns (skills) and identifying the acceptable/unacceptable individual differences in operations using AI techniques. From an AI point of view, this internship will explore how current models can successfully elicit trajectory differences based on the individual differences. Depending on first results, we will most probably devise a hybrid method that will have to be devised to symbolically account for the various gesture choreography.

Supervision Plan:

The internship will be co-supervised by two researchers from LIRMM: Dr. Chao Liu (CR, CNRS) from the DEXTER team of the Robotics Department, a robotics expert and Prof. Madalina Croitoru (Professor, UM) from the IDH team of the Robotics Department, an expert in Artificial Intelligence. Dr. Liu will primarily oversee the experiment design, data collection, and signal processing. Prof. Croitoru will focus on data analysis using AI techniques. Additionally, a PhD student working with Dr. Liu will assist the intern in designing and implementing the experiments.

Candidate Requirements:

The ideal candidate should have a strong foundation in signal processing and artificial intelligence, with proven proficiency in programming using Python and/or C++. Prior experience with robotics or medical-related projects is desirable. Strong communication skills in English are preferred. To apply please email chao.liu@lirmm.fr and croitoru@lirmm.fr with a CV and the transcript of your M1 grades.

Bibliography:

1. D. I. Anderson, K. R. Lohse, T. Lopes and A. K. Williams, “Individual differences in motor skill learning: Past, present and future”, Human Movement Science 78, 102818, (2021)

2. C. Li, C. Liu, A. Huaulmé, N. Zemiti, P. Jannin, P. Poignet, "sEMG-based Motion Recognition for Robotic Surgery Training - A Preliminary Study", 45th Int Conf IEEE Eng Med & Bio Society (EMBC), 2023