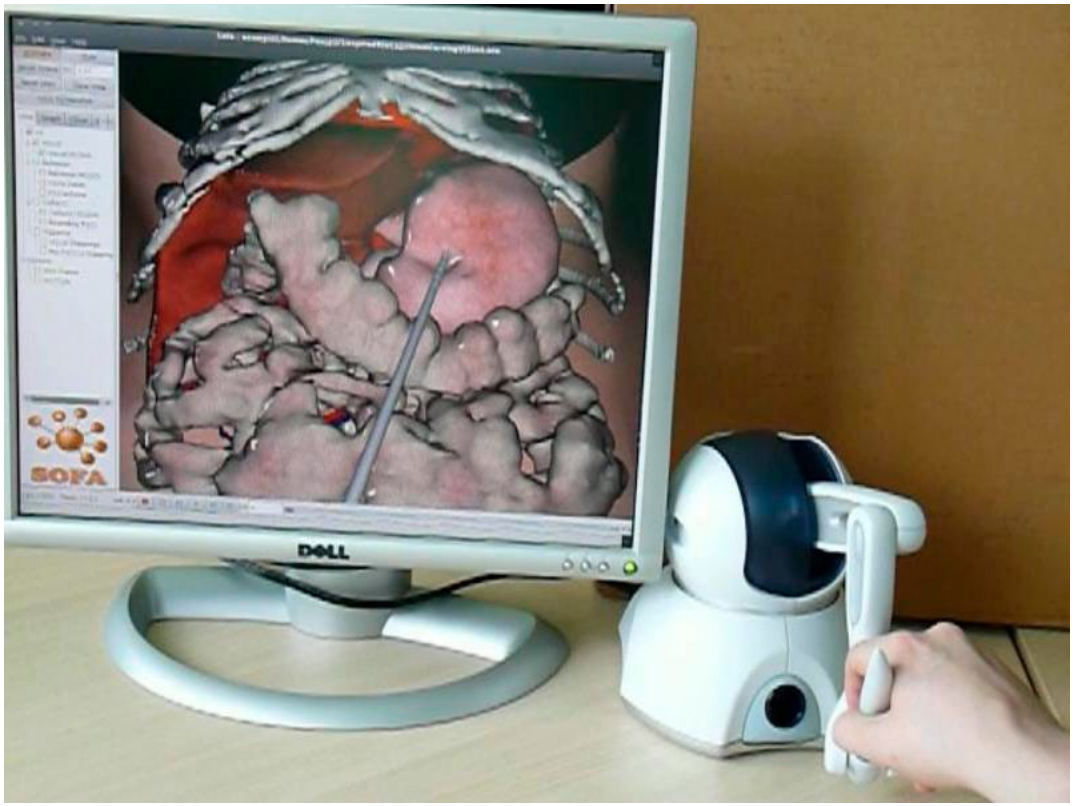
GPU-Based Interactive Simulation of Liver Resection



This GPU-based interactive simulation of laparoscopic liver resection is implemented using the open-source SOFA framework. While similar medical simulators have been developed in the past, this demo relies on advanced methods and the computational power of current GPUs to simulate multiple organs with high-resolution deformations and collisions in real time. It is based on recently proposed methods: high-resolution Finite Element Model (FEM) with implicit time-integration implemented on GPU, volume-contact constraints, an efficient numerical solver based on asynchronous preconditioning, and improvements in visual and haptic rendering. And it uses detailed meshes generated from segmented CT scans to facilitate reproduction of patient-specific scenarios, which is necessary for pre-operative rehearsal of complex or risky medical procedures.

These methods allow real-time simulation of all organs in the abdominal cavity using an improved level of precision compared to previous systems. The FEM formulation enables reproduction of specific material properties. Contacts are handled by precise constraints with frictions on detailed surface meshes. Both methods efficiently support topological changes, as demonstrated by performing a resection of a portion of a liver, an important step in surgical procedures performed to remove cancerous tumors. Users can examine the mechanical and collision models, and the generated contacts while the simulated patient is breathing, and manipulate a laparoscopic instrument to navigate through the abdominal cavity, push on organs, and perform a thermal ablation.

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