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Research In-Progress

System and Method for Continuous Critical Tissue Tracking in Surgical Procedures

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Introduction: A key aspect of surgical navigation is the ability to track critical structures in real time, allowing surgeons to navigate through complex anatomical structures with unparalleled accuracy. Real-time tracking of critical soft tissue structures using computational and non-invasive methods remain a challenge, particularly in scenarios involving tissue occlusion, deformation, or manipulation. We present a AI-based tissue tracking technology that enables visual tracking and annotation of soft tissue during procedures using optical and computational methods.

Methods: The system integrates a machine learning-based tracking module with imaging devices such as endoscopes or a microscopes. Utilizing a neural network, the model processes video feeds, tracking surgeon-annotated tissue regions in real time. The interface allows surgeons to annotate critical structures pre-op, while the real-time visual feedback is displayed. The system was tested using a dataset comprising surgical videos across different procedures, including laparoscopy, neurosurgery, and robotic-assisted surgeries. Performance was evaluated on tracking accuracy, processing speed, and robustness against occlusion and deformation.

Preliminary Results: The system demonstrated robust real-time tracking of critical tissue structures with high accuracy under diverse surgical conditions. It successfully maintained tracking during tissue occlusion and deformation, outperforming traditional computer vision methods such as optical flow. The non-invasive design eliminated the need for contrast dyes, enhancing patient safety and simplifying preoperative procedures.

Next Steps: The early results indicate that our tracking model can significantly enhance intraoperative navigation. The ability to integrate seamlessly existing navigation tools further amplifies its impact. We also see use cases for post operative analysis of surgical video for training and education. Future work is required to validate performance in clinical settings, improve tracking performance and optimizations for different surgical procedures. We are searching for collaborators to further validate the clinical value of our work and assist in further developing the technology. More information is available at:
<https://mikhailchowdhury.com/tissuetrack/>

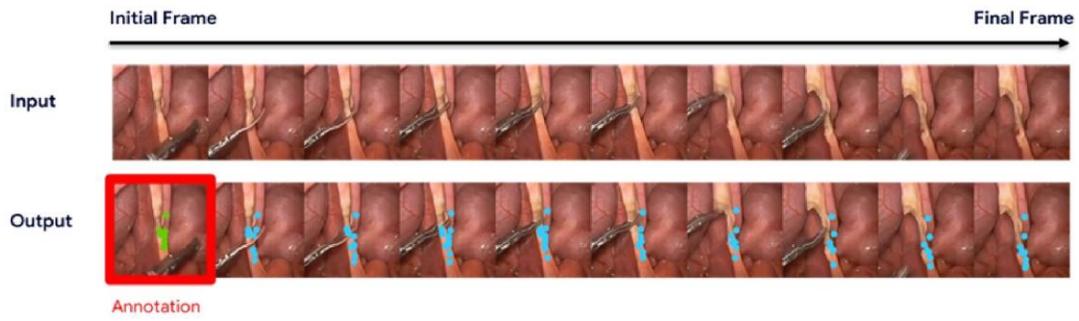


Illustration of the software interface displaying annotated tissue regions in a real-time video feed