Virtual ACS 2021 Surgeons and Engineers: A Dialogue on Surgical Simulation Meeting

Research

Open Source Platform for Automated Collection and Interpretation of Training Data in Open Surgery

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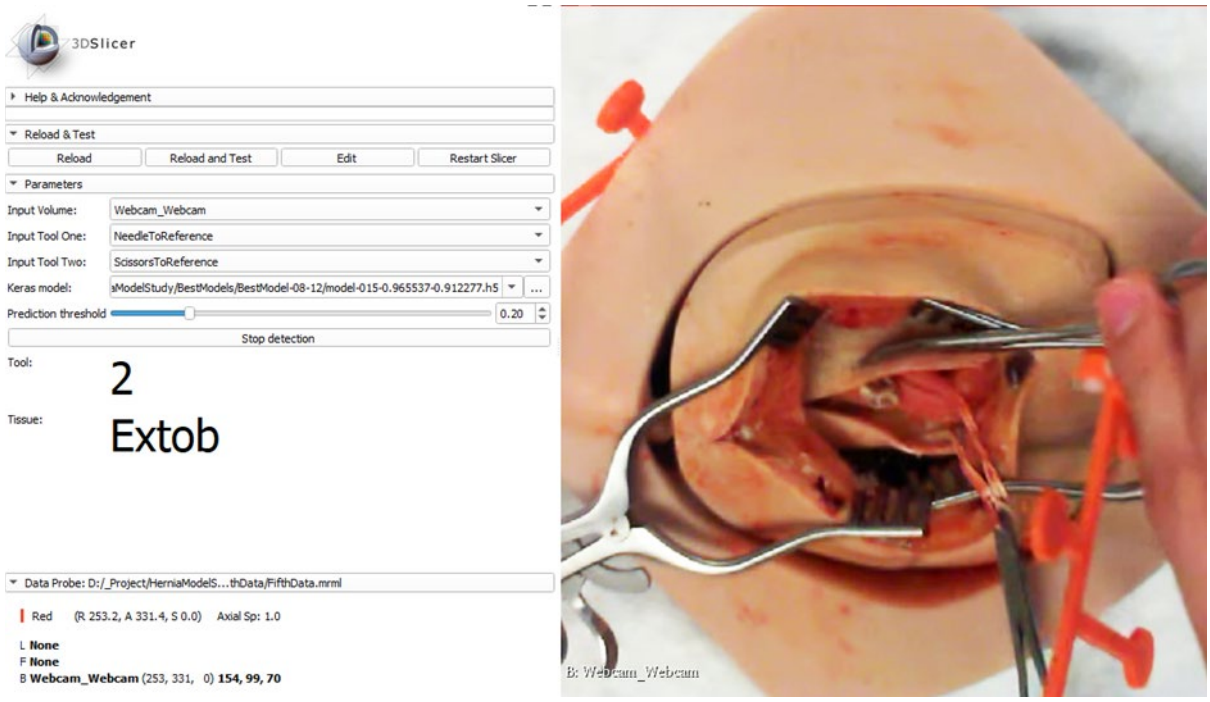
Introduction: Automatic detection of workflow steps in surgery could improve surgical training. Additionally, automatic surgical video annotation could generate useful surgical training material. A platform to collect and organize tracked video data would enable rapid development of deep learning solutions for surgical video annotation in open surgery. The purpose of this research was to demonstrate surgical video annotation on the 3D Slicer / PLUS Toolkit platform by classifying and annotating tissue-tool interactions in simulated open inguinal hernia repair.

Methods: PLUS Toolkit collected tracking data from an optical tracker and video data from a camera, which were saved in 3D Slicer. To demonstrate the platform, we identified tissues being interacted with in surgical video using a neural network and identified the tool in use with the tracking data. A custom Slicer module was used to deploy this model for real-time annotation.

Results: This platform allowed the collection and organization of over 120,000 labelled tracked video frames for training a convolutional neural network (CNN) to detect tool interactions with tissues. The CNN was trained on this data and applied to new data with a testing accuracy of 86%. The model's predictions can be weighted over several frames with a custom Slicer module to improve accuracy.

Conclusions: Our proof of concept model successfully identified tissues with a trained CNN in real time (30fps), while optical tracking data identified the tool. The 3D Slicer and PLUS Toolkit platform is a viable platform for rapidly collecting a large volume of training data in short time. The platform allows deployment of a solution utilizing optical tracking and video processing for real-time annotation (Figure 1). This motivates further use of 3D Slicer / PLUS in video annotation and training in open surgery.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Restart Slicer
Parameters
Input Volume:
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Input Tool One:
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Input Tool Two:
ScissorsToReference
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