Eye-hand coordination

Eye-hand coordination (also known as hand–eye coordination) is the coordinated control of eye movement with hand movement and the processing of visual input to guide reaching and grasping along with the use of proprioception of the hands to guide the eyes.

In microsurgery, surgeons use micro instruments under high magnifications to handle delicate tissues. These procedures require highly skilled attentional and motor control for planning and implementing eye-hand coordination strategies. Eye-hand coordination in surgery has mostly been studied in open, laparoscopic, and robot-assisted surgeries, as there are no available tools to perform automatic tool detection in microsurgery. Koskinen et al. introduced and investigated a method for simultaneous detection and processing of micro-instruments and gaze during microsurgery. They trained and evaluated a convolutional neural network for detecting 17 microsurgical tools with a dataset of 7500 frames from 20 videos of simulated and real surgical procedures. Model evaluations result in mean average precision at the 0.5 thresholds of 89.5-91.4% for validation and 69.7-73.2% for testing over partially unseen surgical settings, and the average inference time of 39.90 ± 1.2 frames/second. While prior research has mostly evaluated surgical tool detection on homogeneous datasets with a limited number of tools, they demonstrated the feasibility of transfer learning and conclude that detectors that generalize reliably to new settings require data from several different surgical procedures. In a case study, they applied the detector with a microscope eye tracker to investigate tool use and eye-hand coordination during an intracranial vessel dissection task. The results show that tool kinematics differentiate microsurgical actions. The gaze-to-microscissors distances are also smaller during dissection than other actions when the surgeon has more space to maneuver. The presented detection pipeline provides the clinical and research communities with a valuable resource for automatic content extraction and objective skill assessment in various microsurgical environments [1)].

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