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 is 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].

1)
Koskinen J, Torkamani-Azar M, Hussein A, Huotarinen A, Bednarik R. Automated tool detection with deep learning for monitoring kinematics and eye-hand coordination in microsurgery. Comput Biol Med. 2022 Feb;141:105121. doi: 10.1016/j.compbiomed.2021.105121. Epub 2021 Dec 11. PMID: 34968859.