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Research Abstracts

SynISS - A Public Challenge and Dataset of Simulated Synthetic Images for Instrument Segmentation in Surgery

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Introduction: A common limitation noted by the surgical data science community is the size of datasets and the resources needed to generate training data at scale to power AI systems. The use of synthetic data (simulation) to train algorithms than can analyze real world data has emerged as a solution. Synthetic data has multiple benefits like free annotations at large scale, possibility to collect larger sample of rare events, along with variations in surgical operating workspace like anatomy, lighting, smoke, etc.

Methods: A dataset of 3000 images along with automatically generated pixel-level instrument annotations was obtained from a robotic surgery virtual reality simulator. Eight variations of a simulated anatomical scene developed for energy-based vessel dissection were used with two types of instruments present in the scene. A public machine learning challenge was hosted inviting participating teams to submit their algorithms to identify instrument pixels in a separate test dataset of 360 images. Dice Similarity Coefficient (DSC) was used to compare algorithm performance. Bootstrapping with 1000 iterations to resample the test dataset was performed to compute ranking robustness to test data using recommended metrics

Results: Twelve teams successfully completed the challenge with overall high DSC values: 0.74 and 0.91 for the lowest and highest scoring teams respectively. Ranking analysis showed robustness to the test dataset as the winning team stayed the winning team 99% of the 1000 bootstrap iterations. Only one other team became the winner in the bootstrap iterations. Segment Anything Model and Maskformer models were the winners.

Conclusions: The Syn-ISS challenge has generated evidence in the use of automatically annotated simulation images for instrument segmentation. Public release of the Syn-ISS dataset will accelerate research in this domain of transfer learning from simulation to the real world to fuel the AI systems transforming surgical intraoperative care and surgical coaching.