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From Point to Mask: Interactive Segmentation for 3D Ultrasound

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Introduction

Segmentation is a widely used tool in the clinical workflow, hindered by high manual effort. Nowadays a large number of trained models exist, often trained on a broad spectrum of data. In this work we evaluated how existing large-scale models perform for the task of 3D ultrasound (3DUS) segmentation, comparing several models across a multitude of datasets and prompt types.

Methods

Three openly available models were used for comparison: SAM2, MedSAM2 and nnInteractive, representing general-purpose, domain-adapted, and medically dedicated architectures. All methods were tested on four different 3DUS datasets with varying anatomies and four different prompt types, to evaluate how well the models generalize and how prompt type impacts the prediction. We evaluated point-based prompts with one positive point only or one positive and four negative points, and bounding box and mask prompts. All prompts were calculated from the available ground truth masks. 3D volumes were split into image stacks across the sweep axis and prediction was done in video mode for SAM-based models, while nnInteractive used 3D segmentation methods.

Results

Segmentation results were evaluated using the Dice Similarity Coefficient (DSC) and the 95th percentile Hausdorff Distance. A clear prompt-dependent trend was observed. Point-based prompts performed worst overall (single-point: mean DSC 0.27-0.63, multi-point: mean DSC 0.41-0.57), while bounding box and mask prompts produced clinically usable results across all models (mean DSC 0.73-0.78 and 0.80-0.82 respectively). HD95 varied substantially across datasets (mean HD95 15-95 voxels) displaying anatomical variability in datasets.

Conclusion

For prompt types with higher manual effort, all models performed reasonably well for clinical use. Bounding box prompts in particular offer a practical trade-off between annotation effort and segmentation quality suitable for clinical workflows. Future work should focus on varying prompt placement to resemble real-life clinical practice and incorporate multi-axis processing into SAM-based methods to better exploit volumetric information.

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