Synthetic Tumors Make AI Segment Tumors Better

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Motivation

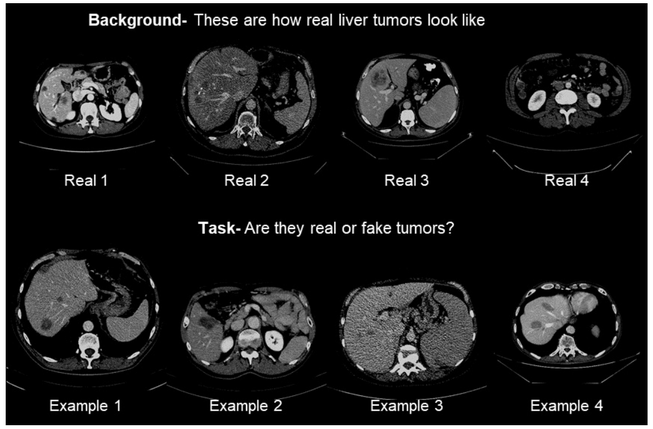
Problem

Artificial intelligence (AI) has dominated medical image segmentation, but training an AI model often requires a large number of **detailed per-voxel annotations**. Annotating medical images is not only expensive and time-consuming, but also requires **extensive medical expertise.**

Solution

To reduce annotation costs, generating **synthetic tumors** is an emerging research topic. In this paper, we develop a novel strategy to generate synthetic liver tumors. Our strategy have two ***intriguing*** advantages:

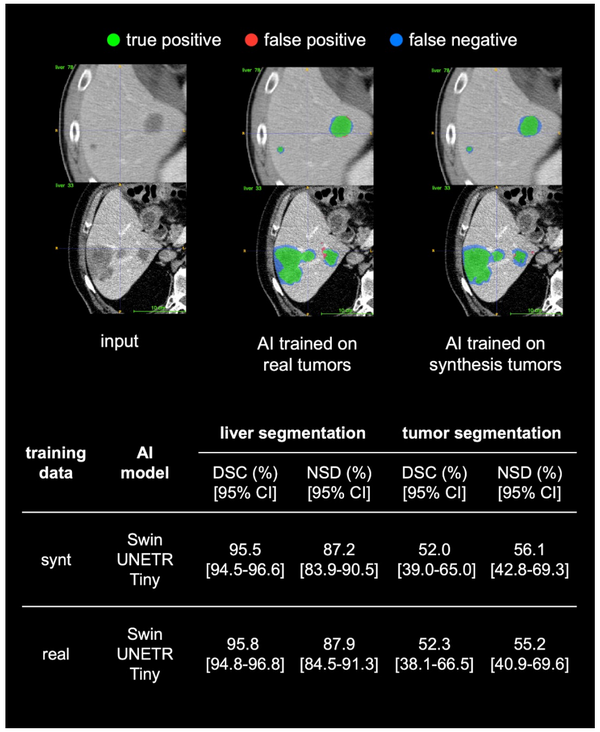
- Realistic in shape and texture, which even **medical professionals** can confuse with real tumors;
- Effective for training AI models, which can perform liver tumor segmentation **similarly** to the model trained on real tumors



Visual Turing Test

Experiment Setup

Task: Liver Tumor Segmentation
AI Model: Swin-UNETR-Tiny[1]
Real Data: Detailed per-voxel annotations of liver tumors in the LiTS[2] dataset.
Synthetic Data: Healthy liver assembled from 4 different dataset.



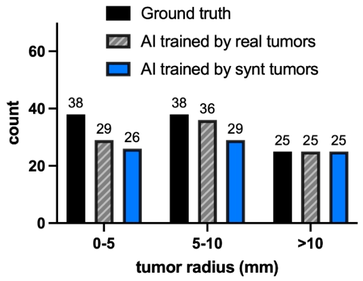
training data	AI model	liver segmentation		tumor segmentation	
		DSC (%) [95% CI]	NSD (%) [95% CI]	DSC (%) [95% CI]	NSD (%) [95% CI]
synt	Swin UNETR Tiny	95.5 [94.5-96.6]	87.2 [83.9-90.5]	52.0 [39.0-65.0]	56.1 [42.8-69.3]
real	Swin UNETR Tiny	95.8 [94.8-96.8]	87.9 [84.5-91.3]	52.3 [38.1-66.5]	55.2 [40.9-69.6]

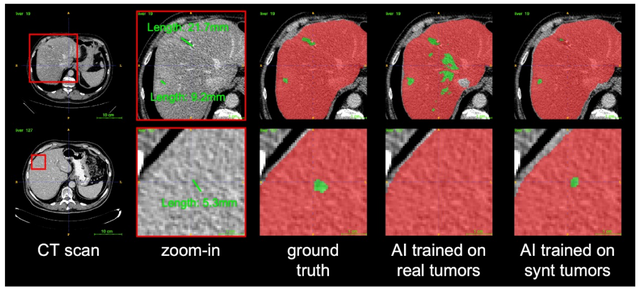
Segmentation Results

Results

- A professional with 6-year experience results show an accuracy of 60% in Visual Turing Test.
- Synthetic tumor achieves **similar** DSC and ***higher*** NSD compare to real tumor in tumor segmentation.
- Our synthetic tumor have the potential to facilitate small tumor detection.

This result is ***unprecedented*** because no existing work, using synthetic tumors only, has thus far reached a similar or even close performance to the model trained on real tumors.





Small Tumor Detection

Reference:

[1] Tang, Yucheng, et al. "Self-supervised pre-training of swin transformers for 3d medical image analysis." *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition*. 2022.
[2] Bilic, Patrick, et al. "The liver tumor segmentation benchmark (lits)." *Medical Image Analysis* (2022): 102680.