MSc Project: Temporal Landmark Tracking on Medical Imaging

Abstract:

Even though various learning-based computer vision methods have been developed for pixel tracking, motion estimation in video data depicts a challenging task. Part of the problem arises from the 3D-to-2D projection process that can lead to out-of-plane motion, which impedes long-range pixel trajectory estimation.

In the medical domain, video data, i.e. fast magnetic resonance imaging (MRI) sequences, can be used for guidance during treatment. Specifically, in radiation therapy, contouring algorithms are used for tracking of the target volume supposed to receive the main radiation dose during treatment [2]. Delineation can, for example, be performed with a U-Net architecture [3].

However, such an approach only allows for identification of larger structures, while irregular movement can be subtle and localized. Landmark detection models are able to identify such localized regions between different representations of the same object. Furthermore, they are faster than semantic segmentation models, and therefore, allow for computer aided intervention during treatment.

In this thesis, different state-of-the-art landmark and pixel tracking algorithms [1, 4, 5] will be tested and further enhanced to identify movement on temporal imaging data of the lungs, i.e. 4D CT. Furthermore, ability of such landmarks to identify movement differing from a *normal* state, i.e. allowing for identification of anomalies, will be studied.

Requirements:

- Prior experience and good understanding in deep learning and computer vision
- Very good programming skills in Python and PyTorch
- Interest in medical imaging

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Application:

Please send a mail, involving a CV, a current transcript of records and a brief statement on why you are interested in the project, to daniel.lang@tum.de or anna.reithmeir@tum.de.

References

[1] Xiao, Yuxi, et al. "SpatialTracker: Tracking Any 2D Pixels in 3D Space." *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition.* 2024.

[2] Fast, Martin F., et al. "Tumour auto-contouring on 2D cine MRI for locally advanced lung cancer: A comparative study." *Radiotherapy and Oncology* 125.3 (2017): 485-491.

[3] Ronneberger, Olaf, et al. "U-net: Convolutional networks for biomedical image segmentation." *Medical image computing and computer-assisted intervention–MICCAI 2015*, Springer International Publishing, 2015.

[4] Zhu, Heqin, et al. "You only learn once: Universal anatomical landmark detection." *Medical Image Computing and Computer Assisted Intervention–MICCAI 2021*, Springer International Publishing, 2021.

[5] Yan, Ke, et al. "SAM: Self-supervised learning of pixel-wise anatomical embeddings in radiological images." *IEEE Transactions on Medical Imaging* 41.10 (2022): 2658-2669.