High-res MRI compounding with implicit neural representations

Project Management and Software Development
for Medical Applications

General Info

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Project Abstract

During MRI acquisition, three separate images are acquired which each has high resolution in one of the transversal, axial or frontal planes and a low resolution along the other axis. Since there is a slight movement between these acquisitions, fusion of the images is not straightforward. In this project we will look into the employment of implicit neural representations (INR) with deformations to construct a high-resolution 3D MRI.

Background and Motivation

Multi-parametric MR is used in prostate cancer detection to detect the suspicious areas. High resolution imaging can increase the detection rate. In current practice, three separate images are acquired and the clinicians mark the areas using all three. By compounding the three images into a single high-resolution the speed and the accuracy of the detection would increase.

To reach this goal, we can assume that all the three volumes available to us are different visualizations of canonical high-res image with minor deformations. We are interested in finding the canonical form from the three acquisitions. To this end we will look into the application of INR with deformations in the medical field. The final result would be deep learning method that can learn a neural network model for each MRI image.

Student's Tasks Description

1. Becoming familiar with the papers on this regarding in INR and INR with deformations
2. Modifying the basic INR architecture to model MR images
3. Implementing the deformation-aware method to account for deformations between the three acquisitions.
4. modify the visualization software provided for INRs in computer vision to adapt to MRI visualization and visualize the canonical high-res image MRI.

Technical Prerequisites

- Machine learning and deep learning
- Python
- Pytorch

References

[1] Q. Wu et al. IREM: High-Resolution Magnetic Res-onance Image Reconstruction via Implicit Neural Representa-tion.Lecture Notes in Computer Science, 2021

[2] V. Sitzmann, J. N. Martel, A. W. Bergman, D. B. Lindell, andG. Wetzstein. Implicit neural representations with periodic ac-tivation functions. InProc. NeurIPS, 2020.

[3] Ben Mildenhall et al. "NeRF: Representing Scenes as Neural Radiance Fields for View Syn-thesis". In:ECCV. 2020.

[4] Keunhong Park et al. "Nerfies: Deformable Neural Radiance Fields". In:ICCV(2021).

Please send the completed proposal to ardit.ramadani@tum.de, lennart.bastian@tum.de and tianyu.song@tum.de. Please note that this proposal will be evaluated by the BMC coordinators and will be assigned to a student only in case of acceptance.