3D reconstruction from 2D x-ray images

Project Management and Software Development
for Medical Applications

General Info

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Project Abstract

Nowadays, with the advancement of Deep Learning and Machine Learning techniques, there is no need to have 360-degree images of objects for 3D reconstructions. The goal of the project is to have a Deep Learning neural network implemented for 3D reconstruction from 2D x-ray images.

Background and Motivation

The need to have a 3D representation of vessel tree of the heart is very important. In the last years there have been many research initiatives to have automatic segmentation of heart vessels in order to identify any stenosis or enlargements of the coronary arteries. Nevertheless, these problems are quite complex due to the planar imaging modality of the x-ray technology during the intervention. Therefore, the aim of the project is to implement one deep learning neural network that would enable us to input one (or two) planar x-ray images, and it would output the 3D reconstruction of it [1], [2] and [3].

For the project, there will be provided VPN access to a GPU server (1 GPU) for training and testing. As well as there will be provided storage space for storing the datasets (NAS).

Student's Tasks Description

The student would have to go through the following tasks in order to fulfill all the requirements for the project:

- Research on the area of 3D reconstruction from 2D x-ray images and present results.
- Compile a list of publicly available datasets of 2D x-ray images with ground truth reconstructions preferably from the Heart Vessels or Heart Anatomy.
- Generate a large amount of training images in the form of DRRs from CT/MRI data
- Implement a Deep Learning network that fulfills the tasks of 3D reconstruction from 2D x-ray images such as [4] and [5].
- Validate your results in comparison to the ground truth and present your results.

Technical Prerequisites

- Experience with C++ and Python
- Experience with Tensorflow/Pytorch
- Basic Computer Vision, Machine Learning, Deep Learning and Projective Geometry knowledge
- Knowledge on GPU server (Cubernetis – Polyaxon) project deployment can be helpful
- Linux (Ubuntu) basic knowledge can be helpful

References

[1] P. Henzler, etl al. "Single-image Tomography: 3D Volumes from 2D Cranial X-Rays", [Online] https://arxiv.org/pdf/1710.04867.pdf

[2] P. Deuflhard, et al. "3D Reconstruction of Anatomical Structures from 2D X-ray Images",

Please send the completed proposal to javier.esteban@tum.de, ardit.ramadani@tum.de, mf.azampour@tum.de and zl.jiang@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.

[Online] https://www.zib.de/projects/3d-reconstruction-anatomical-structures-2d-x-ray-images

[3] S. Hosseinian, et al "3D Reconstruction from Multi-View Medical X-Ray Images – Review and Evaluation of existing methods" [Online] https://www.int-arch-photogramm-remote-sens-spatial-inf-sci.net/XL-1-W5/319/2015/isprsarchives-XL-1-W5-319-2015.pdf

[4] Kanazawa, Angjoo, et al. "Learning category-specific mesh reconstruction from image collections."*Proceedings of the European Conference on Computer Vision (ECCV),*2018. [Online] https://arxiv.org/pdf/1803.07549.pdf, Code: https://github.com/akanazawa/cmr

[5] Gkioxari, Georgia, Jitendra Malik, and Justin Johnson. "Mesh r-cnn." *Proceedings of the IEEE International Conference on Computer Vision*. 2019. [Online] https://arxiv.org/abs/1906.02739, Code: https://github.com/facebookresearch/meshrcnn