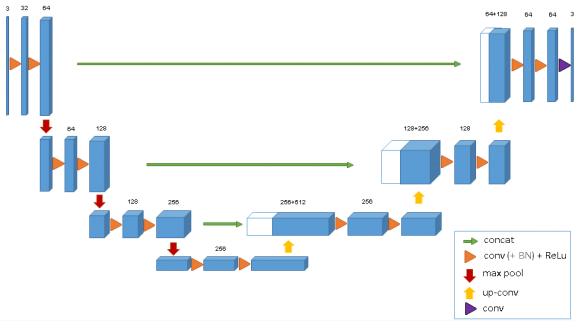
Machine learning for corrective surgery

Amsterdam UMC, Univ. of Amsterdam, Location Academic Medical Center,
Dept. of Biomedical Engineering and Physics, www.amc.nl/bmep

An internship position is available at the Biomedical Engineering and Physics department of the Academic Medical Center (AMC). In our group, new treatment and diagnostic procedures based on innovative physical techniques are developed. Research is performed by a multidisciplinary team that includes physicists, engineers, mathematicians, medical doctors, biologists, and chemists.



U-Net Deep Neural Network

Polygon mesh of an affected (orange) and a healthy bone (green)

Background

In approximately 5% of the cases, a bone fracture leads to malunion of bone segments causing chronic complaints, reduced function and finally osteoarthritis. The AMC is one of the leading academic hospitals for corrective surgery using patient-specific instruments[1,2], which is based on a preoperative CT scan and 3D virtual planning. In preoperative planning, virtual bone models are created by image segmentation[3]. During the image segmentation procedure image voxels are identified (either semi-automatically or manually) that describe a bone. Once the bone voxels are known, a polygon mesh can be extracted, which is the virtual representation of a bone. Segmentation is sometimes a time consuming task which may be simplified by introducing machine-learning algorithms.

Deep learning is a type of machine learning that is revolutionizing the field of medical image processing, thanks to the availability of fast Graphical Processing Units (GPUs) and large image databases. Specifically, U-Nets are now frequently being used for segmentation purposes.

Research description

In this project you will investigate and apply the U-Net algorithm for the segmentation of CT scans of the lower arm bones, and the radius in particular. Many CT scans have already been segmented using conventional technology and serve as gold standard for comparing the newly developed technique.

Requirements

Bachelor/Master student (engineering sciences) with interest in 3D imaging and knowledge of –or interested in- Python programming. The internship duration can be adjusted according to the curriculum.

Learning outcome

The student will gain knowledge in the field of 3D imaging, surgical planning, developing machine learning applications and with programming. Being part of an interdisciplinary and international

research group the student will acquire competences including: collaboration, scientific writing, and presentations.

References

1. G. Caiti, J.G.G. Dobbe, A. Loenen, S.D. Strackee, G.J. Strijkers, G.J. Streekstra, Implementation of a semi-automatic method to design patient-specific instruments for corrective osteotomy of the distal radius, Int. J. Comp. Assist. Rad. Surg., online dec 2018.
2. J.G.G. Dobbe, S.D. Strackee, G.J. Strackee, Minimizing the translation error in the application of a single-cut oblique rotation osteotomy: Where to cut?, IEEE Trans Biomed Eng, 65(4):821-827, 2018.
3. Dobbe J.G.G., Strackee S.D., Schreurs A.W., Jonges R., Carelsen B., Vroemen J.C., Grimbergen C.A., Streekstra G.J., "Computer-assisted planning and navigation for corrective distal radius osteotomy, based on pre- and intraoperative imaging", IEEE Trans. Biomed. Eng., 58(1), pp. 182-190, Jan. 2011.
4. 3D U-Net: Learning Dense Volumetric Segmentation from Sparse Annotation. Özgün Çiçek, Ahmed Abdulkadir, S. Lienkamp, Thomas Brox, Olaf Ronneberger Medical Image Computing and Computer-Assisted Intervention (MICCAI), Springer, LNCS, Vol.9901: 424--432, Oct 2016

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