

Abstract: Towards Automatic C-Arm Positioning for Standard Projections in Orthopedic Surgery

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Guidance and quality control in orthopedic surgery increasingly relies on intra-operative fluoroscopy using a mobile C-arm. The accurate acquisition of standardized and anatomy-specific projections is essential in this process. The corresponding iterative positioning of the C-arm is error-prone and involves repeated manual acquisitions or even continuous fluoroscopy. To reduce time and radiation exposure for patients and clinical staff, and to avoid errors in fracture reduction or implant placement, we aim at guiding - and in the long run automating - this procedure. In contrast to the state of the art, we tackle this inherently ill-posed problem without requiring patient-individual prior information like pre-operative computed tomography scans, and without requiring additional technical equipment besides the projection images themselves. We propose learning the necessary anatomical hints for efficient C-arm positioning from *in silico* simulations, leveraging masses of 3D CTs. Specifically, we propose a convolutional neural network regression model that predicts 5 degrees of freedom pose updates directly from 2D projections. Quantitative and qualitative validation was performed for two clinical applications involving two highly dissimilar anatomies, namely the lumbar spine and the proximal femur. Starting from one initial projection, the mean absolute pose error to the desired standard pose is iteratively reduced across different anatomy-specific standard projections. Acquisitions of both hip joints on 4 cadavers allowed for an evaluation on clinical data, demonstrating that the approach generalizes without re-training. Overall, the results suggest the feasibility of an efficient deep learning-based 2-step automated positioning procedure, which is trained on simulations. This work was first presented at IPCAI 2020 [1].

References

1. Kausch L, Thomas S, Kunze H, et al. Towards Automatic C-arm Positioning for Standard Projections in Orthopedic Surgery. *IJCARS*. 2020;15:1095–1105.