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Inverse Kinematik Für Röntgen-C-Bögen
The Inverse Kinematics of Fluoroscopic C-Arms

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Introduction

Flouroscopic C-arms are common devices to acquire images during surgery. Manual positioning is time consuming and requires a lot of experience. Even trained personal must typically take a series of images to find an appropriate viewing angle. The approach for an interactive fluoroscope introduced here simplifies the positioning process and reduces the number of x-ray images to be taken. We derived an inverse robot kinematic solution for the c-arm. Our goal is a fully motorized c-arm capable of autonomous motion.

Methods

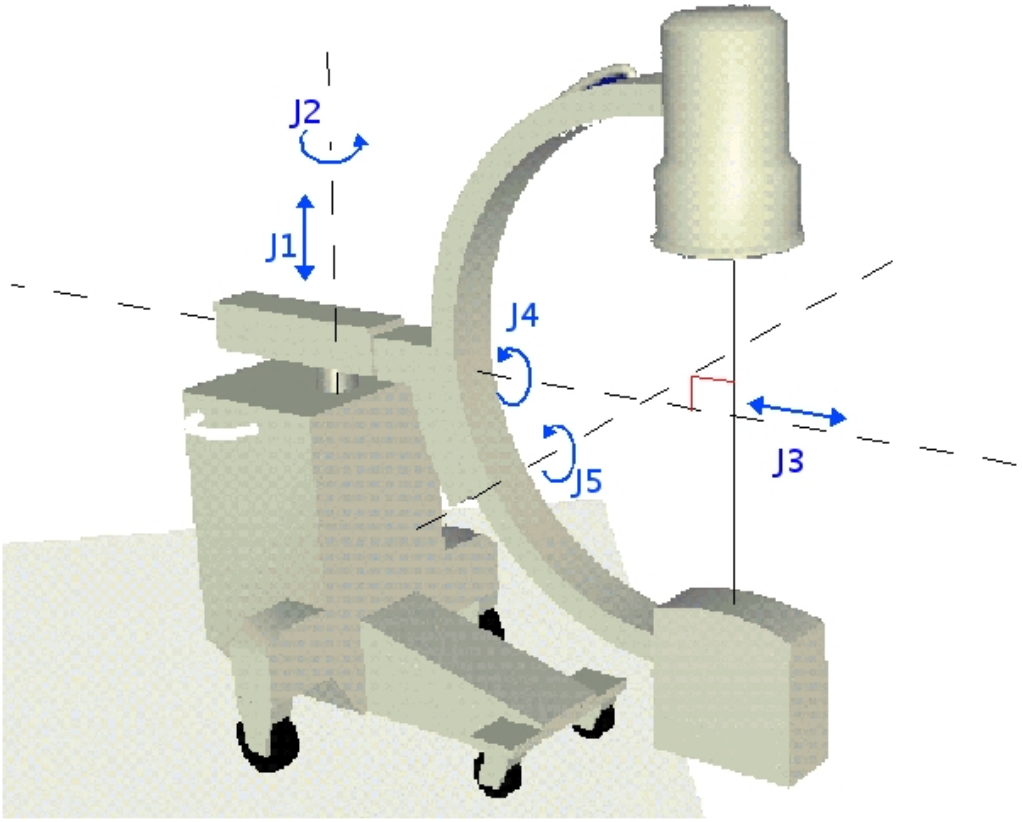
The mechanical construction was analyzed and the direct kinematic problem was solved according to Denavit-Hartenberg method. Due to the limitation of five axes, there is a dependency between the region of interest (ROI) and the orientation of the optical system. During usage, only the ROI and the direction of the beam-center are given. As the last degree of freedom, the rotation around the beam-center, is missing, there is no explicit definition of the transformation matrix between the optical system and the base of the fluoroscope. After setting up the partial homogeneous transformation matrix with the scarce information given, a closed form solution for the inverse problem for c-arms was found.

Results

The kinematic results were applied to our visualization software. The first application was the extraction of 3D information and calculation of the best position for the final image. A large number of potential clinical applications were tested in this context.

Conclusion

Tests were sucessfully applied on our simulation and confirmed by neurosurgical staff of the university clinical center. Future steps include the motorization of our fluoroscope and additional testing in laboratory and clinical environment.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