ORBIT – Open X-ray Scanner for Image-guided Interventional Surgery – Development of Concept

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Abstract: During surgical interventions 3D x-ray imaging systems provide intraoperative control of implant placement and bone fracture repositioning. Conventional 3D x-ray systems, like CTs and 3D C-arms, are characterized by a circular movement of x-ray source and image detector around the patient. Using this technique the radiographed volume is reconstructed accurately, but the patient is fully enclosed and the access for the surgeon is limited. To improve the usability of intraoperative 3D imaging, we developed a new image acquisition method by optimizing the directions of x-ray projections within a limited angle range above the patient. The optimization method is based on the determinability of density changes inside a volume depending on the used directions of x-ray projections. From the optimization results we derived an orbital x-ray source trajectory not enclosing the patient. Using a simulation environment and an experimental set-up we analyzed the developed image acquisition method and compared it with a conventional trajectory. Based on the results, which demonstrate the feasibility and usability, we propose a new system concept of an intraoperative 3D x-ray scanner to realize our orbital image acquisition method. The 3D x-ray scanner ORBIT consists of an x-ray source mounted on a robotic arm, a fixed digital flat-panel detector integrated in the operating table and a control and monitor cart.

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