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ORBIT
Open X-ray Scanner for
Image-guided Interventional Surgery

1 *A 3D C-arm system in use at the Charité – Universitätsmedizin Berlin*
2 *System design for the open 3D X-ray scanner ORBIT*

ORBIT – MORE INSIGHT FOR SURGEONS

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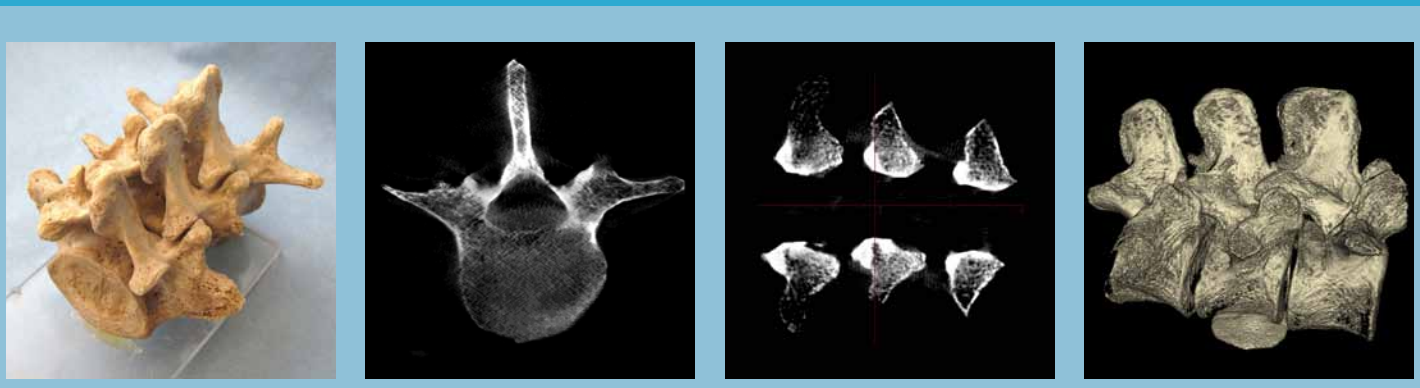
ziehmimaging

Around 1.2 million complex surgical operations are carried out in Germany each year. To reduce the risk of complications and follow-up interventions, physicians use X-ray diagnostics already during the operation to monitor its progress. Two dimensional X-ray images are often not precise enough to allow for an exact assessment of the operating situation. Three dimensional imaging, on the other hand, does give a precise spatial representation of the patient's inner body parts and thus has established itself as an essential auxiliary aid for surgeons. Its major drawback, however, is that thus far the operation has to be suspended to allow for positioning of the 3D imaging equipment. ORBIT is a new development from Fraunhofer IPK, Ziehm Imaging and Charité – Universitätsmedizin Berlin, which can be permanently installed above the operating table thus enabling easier integration in surgical procedures.

Take Spinal Implants…

3D imaging enables physicians to precisely evaluate repositioning of bone fractures in joints, or to calibrate the position of implants with millimeter accuracy and avoid damaging critical anatomical structures. One such example is monitoring the correct position of implants in the spinal cord relative to the highly sensitive nerve channels. To treat fractures and instability in the spinal cord, pedicle screws are used to permanently secure the adjoining vertebrae. It is essential that such interventions do not injure the spinal cord and its cerebrospinal fluid. Yet as two dimensional X-ray imaging cannot supply depth information, incorrect positioning of the implant screws and subsequent injury to the nerve channels cannot always be unerringly excluded. Only 3D imaging can assure accurate monitoring of the implant placement. To carry out needed corrections during the actual operation



1 *Image acquisition with the ORBIT prototype*

and eliminate stressful and cost-intensive follow-up interventions, 3D imaging must be used intraoperatively.

Conventional 3D Systems

Conventional 3D radiography systems like three dimensional C-arm systems or computer tomography for surgical use involve rotation of the X-ray source and X-ray detector in an inflexibly arranged circular path around the patient in order to take individual images from which 3D data can be reconstructed. Such a circular movement ensures high reconstruction quality, yet completely encloses the patient. Permanent installation of such devices at the operating table would impede the surgeon's free access to patients. This means that for each take the equipment must be wheeled to the table, aligned on the patient and then be wheeled back. As a consequence, the operation must generally be suspended for several minutes which puts a considerable strain on surgical procedures and is the reason why surgeons have serious reservations about the routine use of these systems.

Inside ORBIT

To simplify the use of 3D X-ray imaging during operations, ensure free access to patients and shorten recording time, Fraunhofer IPK in partnership with the Charité – Universitätsmedizin Berlin and Ziehm Imaging GmbH is developing the open 3D X-ray scanner »ORBIT«. Funded by the Federal Ministry of Education and Research (BMBF), the project has already won the 2007 and 2010 Innovation Prize for Medical Technology given by the same ministry.

ORBIT is based on a novel recording concept which takes mathematical optimization of the projection alignment to achieve the highest 3D image quality. ORBIT's X-ray source does not move around the patient but moves exclusively in a circular path above him or her. The ORBIT system consists of three modules:

- a swivel arm with a controllable X-ray source (mounted on the ceiling or on a mobile support)
- a digital flat screen detector (integrated in, or secured on, the operating table)
- a display unit (mobile or wall-mounted)

A laboratory prototype has proven the feasibility of this recording concept, and the level of achievable quality has been experimentally investigated in an application for spinal surgery. Though as yet many questions remain unanswered, first project results give rise to optimism that the project goals concerning flexbile and speedily deployable intraoperative 3D X-ray imaging can be reached.

Within the next three years with financial support from the Federal Ministry of Education and Research, the first ORBIT functional prototype will be built in Fraunhofer IPK's Radiography Lab and technically and clinically evaluated in an experimental operating theater at the Charité. The new system will be designed for minimum impact on surgical procedures and routine use in operating theaters.

GEFÖRDERT VOM

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