SUCCESS STORY

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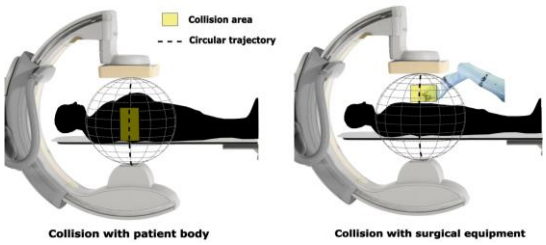
COLLISION AVOIDANCE FOR CONE BEAM CT IMAGING FOR INTERVENTIONAL RADIOLOGY

DEVELOPMENT OF OPTIMIZED AND PERSONALIZED CBCT IMAGING TRAJECTORIES UNDER SEVERE KINEMATIC CONSTRAINTS.

Intraoperative 3D imaging is nowadays feasible thanks to the development of the 3D cone-beam CT (CBCT) technology. CBCT provides better access to the patient at lower radiation dose and cost compared to the clinical CT. A circular source-detector trajectory is required to reconstruct a 3D image, and thus interventional tools often impose restrictions on the available space in the intervention room. As a result, the circular trajectory is not realizable in many cases due to the collisions between the imager and interfering equipment or the patient body.



Two examples of the kinematic constraints in surgery room.

In such situations, the 3D imaging option must be omitted and clinicians need to rely on 2D x-ray images, which can lead to wrong decisions during the surgery or can cause the need for subsequent surgery.

We developed a novel algorithm to design collision-free, patient-specific trajectories for the cases in which circular CBCT is not feasible. Our proposed method tries to optimize the 3D orientation and personalizes the source-detector trajectories by combining multiple small arcs to achieve maximum imaging performance at a desirable region of interest. The realized optimization process can be performed on-the-fly during the intervention while taking into account all available kinematic constraints and unpredicted collisions. Our developed algorithm, for the first time, enables CBCT under kinematic constraints for cases where standard circular trajectory is not feasible.

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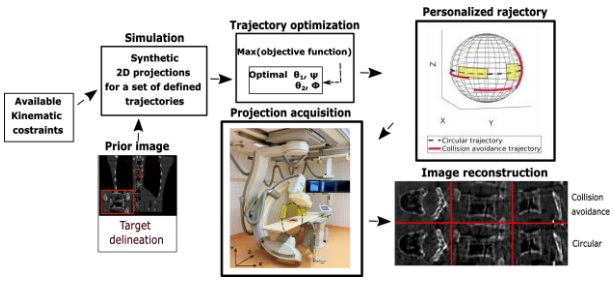
Evaluation of the method reveal that the resulting customized trajectories showed similar imaging performance as the standard circular trajectories. With that, the developed imaging protocol paves the way for the next generation of collision avoidance in 3D CBCT imaging.



Collision avoidance trajectory optimization framework

The imaging framework has been developed in close cooperation with the Center for Medical Physics and Biomedical Engineering, Medical University of Vienna, and the Radiology Department of the Landesklinikum Wiener Neustadt.

Impact and effects

The main clinical benefit of this imaging optimization will be for obese patients and for interventional scenarios where collisions with the patient body or medical devices need to be avoided. The method indeed opens an enormous number of clinical applications to benefit from this collision avoidance, such as pedicle screw insertions, percutaneous needle placement, endovascular aneurysm repair, contrast-enhanced CBCT as an adjunct to angiography procedures and many more.

Further variants of the optimization framework have been identified and are already in preparatory phase, such as imaging procedures with the avoidance of metal artifacts and/or non-isocentric volumetric scanning with an extended field-of view (FOV).

In summary, interventions using CBCT imaging not only potentially release classical CT imaging for diagnostic purposes, but also can make interventions easier, faster, and less traumatic for the patient. Considering the aforementioned advantages, it can be said that the developed extended imaging feature (CBCT under kinematic constraints) will be a strong driver for a more extensive utilization of CBCT imaging in interventional radiology with a very positive impact to all stakeholders along the treatment chain.

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