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Markerless navigation for percutaneous needle insertions

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Percutaneous needle insertions are increasingly used for diagnosis and treatment of abdominal lesions to e.g. perform biopsies or radiofrequency ablations. The success of the needle insertion crucially depends on the ability of the physician to correctly transfer the pre-defined insertion trajectory to the patient. Computer-based navigational approaches to assist percutaneous needle insertions [1] have thus far not become widely accepted in clinical routine, because their benefit to the patient could not exceed the additional hardware complexity and additional higher costs.
In this work, we introduce a navigational approach which improves and simplifies the workflow of navigated needle insertions and holds the balance between the benefits for the patient and the complexity of the system by applying only one single modality for patient localization and instrument guidance.
Due to its considerable costs and its ability to acquire surface data in real-time and without additional radiation exposure to patient or physician, the novel Time-of-Flight (ToF) camera technique [2] was firstly used in the context of interventional radiology.
Transferring the planning data to the actual situation at the patient was done by means of an iterative closest point-based *surface registration* approach. The surface acquired by the ToF camera is registered to the surface extracted from the CT data acquired before the intervention. For *guidance*, the intensity image is augmented with the projection of the instrument. In an alignment step, the physician has to align the instrument in the intensity image with the projection corresponding to the position just before needle insertion. Insertion is then accomplished by advancing the needle such that the shown instrument coincides with the projected final position of the needle.
A feasibility study, conducted with a first prototype of this markerless navigation system, yielded and overall targeting accuracy in the magnitude of 8 mm.
The presented navigational approach is independent of additional markers or tracking hardware and only needs one modality for navigation support. Due to its simple integration into the clinical workflow, its potential impact can be regarded extremely high.

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[2] Kolb, A.; Barth, E.; Koch, R., Larsen, R. *Time-of-Flight Sensors in Computer Graphics.* Eurographics - STAR 2009, 119-134