Dynamic tracking during interactive MRI: Implementation of an open-source middleware

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Target audience: The topic might be of interest for researchers and clinical scientists who operate with real-time MR-guided interventions.

Purpose: In real-time MRI-guided interventions and surgery [1], the field-of-view (FOV) of interactive sequences needs to be permanently changed according to the instruments movement. Dynamic tracking [2] allows the automatic adaption of the FOV to the instruments location acquired by a medical tracking system. To accomplish manufacturer independent use of dynamic tracking, a middleware was developed allowing the use of various MRIs and tracking systems.

Methods: The middleware software serves as an interface between an optical tracking system (NDI Polaris) and the MRI (Philips Panorama HFO). The software requests the current positioning data (translation and rotation of the instrument) from the tracking system. On the basis of these coordinates a MR-valid rotation and translation matrix is calculated and send to the MRI. To simplify the navigation, the target slice and the needle position are represented through virtual levels.
The synchronization between tracking system and MRI (see Fig. 1) was tested with punctures, performed on a phantom (n=100). The attempts were carried out by five inteventionalists and five probands. The time required and the number of corrections (needle retraction) has been measured and compared to reference values [3].

Results: The implemented middleware creates a link between the MRI and the tracking device (see Fig. 2) and reliably aligned the FOV on the puncture needle. If the instrument deviates the predefined path, this is represented graphically. The representation of the image plane and of the current FOV allows a simplified navigation, results in an efficient decrease of procedure time by 22%. The suggested corrections enable also inexperienced interventionalists to reach a higher hit rate and reduce the duration of the intervention. No connections were dropped during the experiment.

Discussion: In the phantom experiment the efficiency regarding to time and success rate could be improved by using a dynamic control with a tracking system. With a dynamic control misunderstandings between doctors and technologists are heavily reduced. Dynamic MR-control allows MR-guided puncture with an intuitive control of the MRI, intuitive orientation of the image plane and finally the reduce of the intervention time.

Conclusions: The efficiency of interventions can be considerably improved through the middleware regarding time and hit ratio. Errors due to misunderstandings between radiologist and radiology assistant are strongly reduced.

References:

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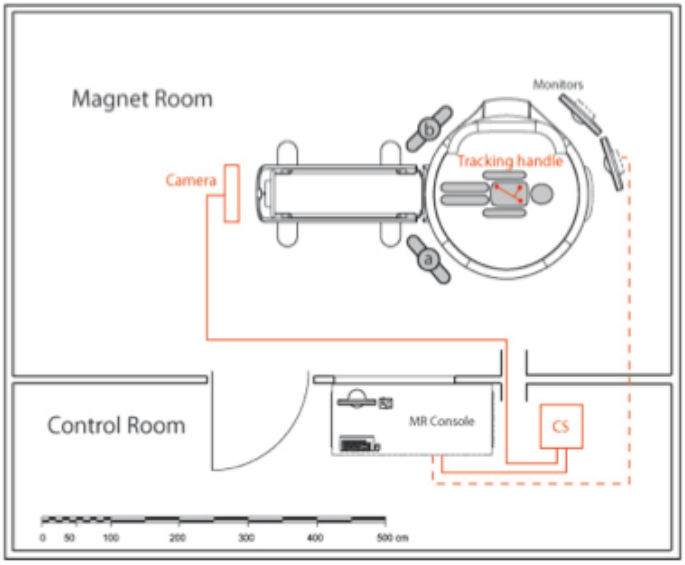

Fig. 1: *Experimental setup for a real-time MR-guided intervention with used of a middleware software (CS). The tracking system (Camera) tracked the instrument with tracking handle in the isocenter. The middleware communicated with the tracking system and MRI to aligned the FOV on the instrument position.*

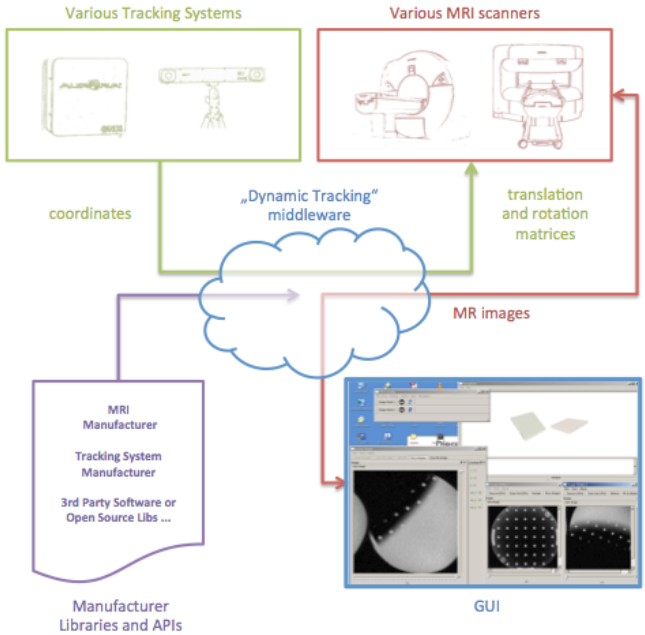

Fig. 2: *The middleware software transmit the current positioning data (translation and rotation of the instrument) from the tracking system to the MRI and allows a automatically FOV adaption. The software is independent of the MRI and tracking system Manufacturers and provide a uniform GUI for the operation.*