Integrating Clinical Neurosurgery Workstations into a Real-time System for Conducting MR-Guided Procedures

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Target Audience

This work will appeal to those interested in MR-guided interventional procedures, particularly in the neurological field.

Purpose

Neurosurgeons are already familiar with using computer-based surgical workstations in the operating room for guiding stereotactic procedures using retrospectively acquired MRI scans. We have previously developed and presented a system for conducting MR-guided and monitored Convection Enhanced Delivery (CED) intracerebral infusions [1], a procedure similar to that involved in inserting Deep Brain Stimulator (DBS) electrodes. The system has proven successful, allowing the authors to perform over sixty targeted infusions in animals with an aiming time of only a few minutes and a total procedure time of about fifteen minutes per insertion [2]. However, successfully translating this system to clinical use would require neurosurgeons to learn a new and unfamiliar software interface. We investigate leveraging commercial surgical workstations to directly drive MR-guided procedures. Specifically, we describe initial work to integrate our existing real-time targeting tools with the Medtronic StealthStation (Medtronic; Minneapolis, MN) surgical planning workstation.

Materials and Methods

The interventional apparatus was a rigid catheter aimed and inserted through the Navigus pivot-point-based aiming system (Medtronics; Minneapolis, MN), which includes a skull-mounted ball-joint pivot base and an MR-visible external trajectory guide. Our targeted drug infusion system was developed as a set of plug-ins for the RTHawk and Vurtigo development environments [3,4]. A high-resolution 3D baseline scan is transferred to both the surgical planning workstation and our real-time workstation using DICOM transfers. The target and entry points are identified in a surgical planning environment familiar to practicing neurosurgeons (Fig. 1) and then automatically transferred into our tools (Fig. 2). We developed a plug-in that automatically transfers target and pivot point coordinates from the StealthStation to our lower-level aiming routine using the StealthLink protocol [5], performing a coordinate conversion between the StealthStation's internal coordinate system and physical scanner coordinates. The system then automatically images an "aiming plane" perpendicular to the desired trajectory guide orientation and outside the body as well as several trajectory-aligned "monitoring planes". While receiving real-time feedback on the position of the external trajectory guide on an in-room monitor, the interventionalist moves the guide until it is centered on a colored "aiming point" marker, then inserts a fused silica catheter to the indicated depth under real-time MR monitoring.

Results and Discussion

Target and entry points specified with the StealthStation were successfully transferred to and used by our interventional system. The visualization and workflow for identifying these points is identical to what neurosurgeons use every day in the OR. In the past, users interacted directly with our system via a visualization window that allowed complete freedom to load and manipulate image datasets. While this system has been appealing to engineers and physicists and was quickly adaptable to use in new and unanticipated ways, the clinical personnel we worked with repeatedly described it as cumbersome and requested that it be simplified to work in a manner similar to the clinical workstations they were familiar with. Allowing procedures to be conducted using the familiar StealthStation planning environment has greatly improved acceptance of MR-guided interventions with our clinical collaborators.

Conclusion and Future Work

Interfacing the commercial StealthStation with our interventional tools allows neurosurgeons to conduct procedures in a familiar treatment planning environment. In the future we plan to further integrate this system, moving the entire user interface for every step of the aiming and monitoring procedures to the StealthStation display.

References

[1] Brodsky EK, *et al.*, Proc. IEEE BSEC 3:63 ('11)
[2] Grabow B, *et al.*, Proc. IMRI Symposium 9:19 ('12)
[3] Santos JM, *et al.*, Proc. IEEE EMBS 26:1048 ('04)
[4] Radau P, *et al.*, Proc. MICCAI/STACOM 244 ('11)
[5] http://www.na-mic.org/Wiki/index.php/Stealthlink_Protocol

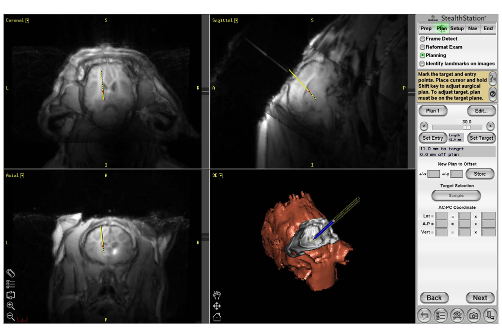

***Figure 1**: The Medtronic StealthStation offers a well-developed and clinically accepted interface for planning neurological interventions. It includes built-in functionality for image registration, volume rendering, trajectory-aligned visualization, and interfacing with stereotactic navigation hardware.*

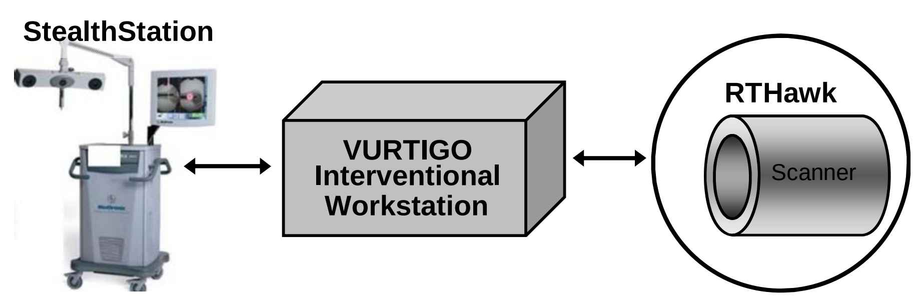

***Figure 2**: Our initial work in MR-guided interventions involved developing a custom user interface running on the VURTIGO platform. This was successfully used for performing experiments in animals, but our clinical collaborators requested that it have an interface similar to the commercial surgical planning tools they were familiar with. Instead of building this from scratch, we instead implemented connectivity with the Medtronic StealthLink surgical planning workstation, allowing users to plan and conduct procedures in a familiar environment, with our tools providing the "behind the scenes" functionality.*