White Paper

Virtual Navigator
Neurosonology

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Creativity in Healthcare

"Technology that combines multi-mode data in real-time offers great clinical advantages and opens wider horizons in Neurosonology"

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Introduction

Virtual Navigator (VN) is an advanced system that allows the real-time display of ultrasound (US) images with other reference imaging modes (CT, MRI, PET, etc.). By overlaying the different images or displaying them side by side, the fusion of data acquired through the different modes is achieved with an increased ultrasound scanning accuracy and confidence. Virtual Navigator is also able to reliably support the user with difficult-to-scan patients and is a valuable and easy to use tool for research, teaching, diagnosis and interventional procedure monitoring purposes. Moreover, 3D ultrasound volumes can be used as reference. Virtual Navigator Advanced Image Fusion System is the best assistant that a physician can have during any interventional procedure phase. Being able to combine ultrasound images with secondary imaging modes increases the reliability of the diagnostic process. Virtual Navigator additionally provides reliable pre- and intra-procedural planning and virtual tracking of different treatment probe modes. Virtual Navigator is actually able to combine the most advanced ultrasound technologies, such as CEUS (Contrast Enhanced Ultrasound) and CFM (but also PW and CW), during scanning and treatment.

Such capability allows clinicians to immediately compare pre and post treatment clinical conditions and to better plan future disease management as well as any kind of follow-up.

Fig. 1

Virtual Navigator Technology in Transcranial Application

Based on this introduction and technology overview, one can see how using Virtual Navigator for Transcranial applications is very quick and easy.

Fig. 1 shows the examination set-up which includes a scanning bed (made in plastic or wood), the complete Virtual Navigator toolkit, a PA240 Phased Array probe with relevant sensor, a proper head support and at least six Multimode Pin Points.

Transferring MRI Data to the US System (Fig. 2) is achieved through multiple options: Network, USB Memory support or CD/DVD (where MRI DICM Data is uploaded).

Fig. 2

The capability to fuse both MRI and US data in real-time, offers the operator the extraordinary opportunity of employing the advantages offered by both technologies.

Ultrasound vs MRI benefits and limitations	
Ultrasound benefits	**MRI benefits**
Real-time display of image features	Detailed view of brain and vessels
Ease of use compared to MRI scanner	Much wider field of view (than US)
Lower cost per image	3D view of the whole brain and head structures
Ultrasound limitations	**MRI limitations**
Patient- and operator- dependent	Anatomical image lacks of functional information
Limited in its FOV and image quality	

MRI - Ultrasound Transcranial

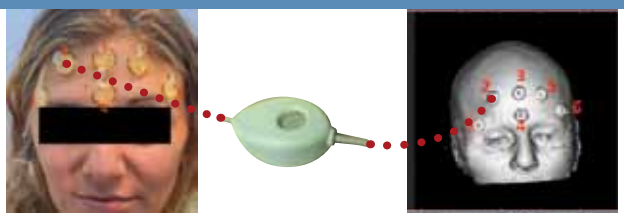
Registration Procedure

Based on the operator's skill and experience, MRI volume registration and real-time ultrasonographic scanning take place either with a single phase or a two phase procedure. For an initial approach, the two phases procedure whereby the operator begins with External Marker Registration and completes the job with Internal Marker Registration is recommended. When the operator has gained enough experience, skipping the External Marker procedure and jumping directly into the Internal Marker one may become more convenient.

External Marker Registration

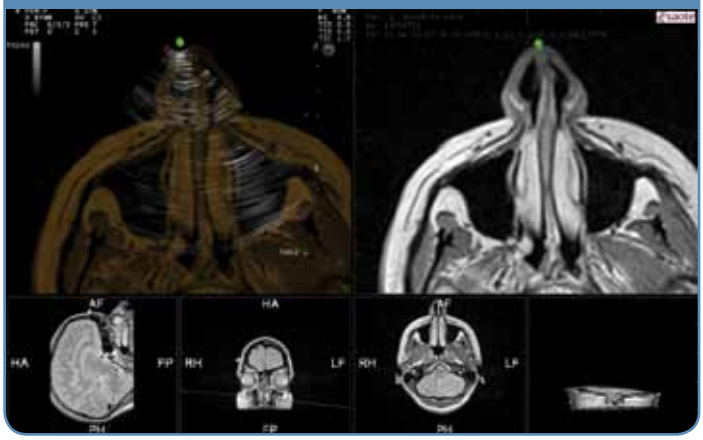
A registration pen (equipped with a transmitter unit) is used to point 6 Fiducial Markers on the patient skin (patient's MRI must be performed with Pin Points already positioned). Computation of the registration matrix (minimizing root mean square of the distances between the identified points in 3D MRI rendering and the corresponding ones in the US-space).

Global registration example



Result: 1st step registration error <0.5 cm –> 2nd step to refine the registration

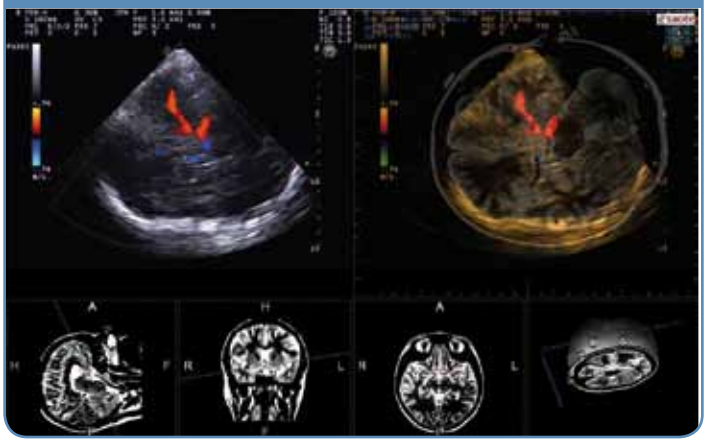
Example of rough quality check of the registration procedure



Internal Marker Registration

Scans acquired from any available Transcranial ultrasound window. Anatomical and Color Doppler landmarks can be used to fine tune the registration procedure.

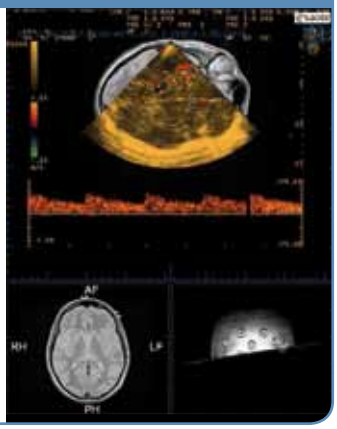
Image registration refinement with superimposition of US Doppler information above the detailed MRI data



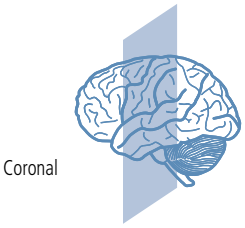
Examples of Virtual Navigator images in Transcranial Application

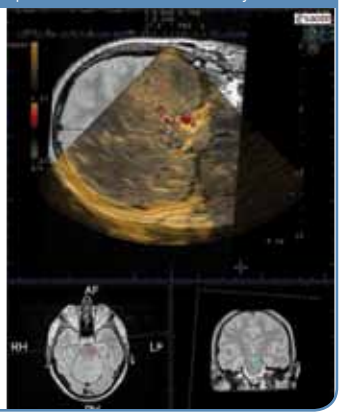
Temporal window

Virtual Navigator use for "Classic" Transtemporal approach
Temporal ultrasound window – Axial plane: Middle cerebral artery



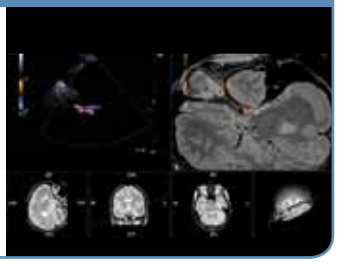
Temporal ultrasound window – Coronal plane: Middle cerebral artery





Condylar window

Superior and Inferior Petrosal Sinuses displayed with US and on the anatomical reference plane given by the MRI data



Visualization of the first segment of the Vein of Rosenthal and the Superior Petrosal Sinus

Conclusion

The fusion of US with MRI data creates a complete high-quality picture, allowing to set insonation plane and vessels targeted by US into MRI's detailed anatomical volume. Its use can be considered to improve the quality of both experts and non-experts performance by delivering the display of fused data during vessel targeting phase.

Fusion Imaging of MRI and US procedures may bridge a connection to vascular (i.e. susceptibility weighted), hemodynamic (i.e. phase contrast), and microstructural (i.e. diffusion) contrast delivered by other MRI modes, using PD MRI as main reference for intra-subject image registration. Better ultrasound windows/approaches for venous system imaging could be available but have not yet been discovered/defined. Such advanced and clever technology has shown to have the potential to be used both in the Research and Teaching field as well as during everyday clinical activity.

References

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