# SmartMove™

Robotized TMS a novel approach to image guided transcranial magnetic stimulation (TMS). The system allows to plan a stimulation session, allowing to define the stimulation sites and the desired coil orientations. While executing the stimulation plan, the robotized TMS system SmartMove places the coil tangentially at the predefined target positions and keeps the coil in place even if the head of the subject moves. The system's main components are a serial robot arm with six joints and a marker-based optical tracking system. Both devices are linked by a control computer, running the software module, for treatment planning and execution.

System Overview

The system consists of the following parts:
1. The robot arm, type Adapt Viper S850 with power supply unit and remote control.
2. The control unit and the software for the robot arm, optical tracking system and the TMS device.
3. NDI Spectra® optical tracking system.
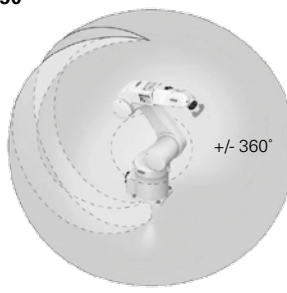

System components
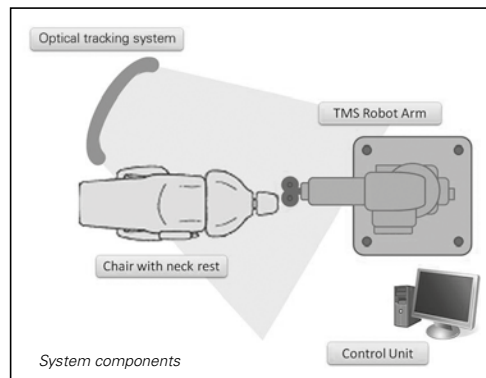
Software Specifications

The robot arm, the optical tracking system and the TMS device are operated by the control unit. The software module allows to plan the stimulation treatment, by defining the stimulation targets and the desired coil orientations. The defined target positions for magnetic stimulation are then forwarded to the robotic arm. During the session, any movement of the subject is monitored with the optical tracking system and compensated for. This guarantees optimal positioning of the TMS coil over the pre-defined target. Magnetic stimulation is done when the TMS coil reaches the pre-defined target location.

MRI Import	• DICOM, Nifti

Targets Definition	• Single Targets:
	  - Based on real scalp surface, by pointing at scalp with the pointer tool
	  - Based on computer rendered surface of subject and mouse clicks
	  - Based on MRI / CT data and mouse clicks
	• Automatically generated target grids, width adjustable height, width and target spacing starting from a previously defined single target

Subject Registration	Anatomical landmarks based and/or ICP based. The ICP is based on surface points automatically collected while moving the pointer over the scalp.
Targeting Mode	• Static (without movement compensation) • Dynamic (with movement compensation)

Stimulation Mode	• Manual. Upon target selection, the robot arm places the coil at the defined position.
	• Automatic. The robot arm places the coil at all defined target positions:
	  - In the specified order
	  - Randomly

Export of stimulated positions	As text file
Dynamic response latency	< 50 ms
Relative accuracy (static target)	< 0.05 mm
In-session-repeatability (static target)	0.03 mm
Inter-session-repeatability (static target)	• 0.03 mm (same fixation) • 1.0 mm (new subject / new chair-robot-arrangement / new coil attachment)

Hardware Specifications

Robotic Arm
The Adept Viper arm is a 6-axis robot designed for a multitude of applications. The precision and physical range of the robot makes it ideal for medical applications requiring flexible and accurate positioning and complete control.

Adept Viper™ s850

**Dimensions
Adept Viper s850
(mm)**

Work Envelope:
Radius 850 mm

Inner Limit:
Radius 166 mm

+/- 360˚

Work enveloppe of the robotic arm

Reach	854 mm
Payload max	2.5 kg (rated)
	5.0 kg (max)
Repeatability (XYZ)	± 0.030 mm
Mounting	Floor / Table / Ceiling
Weight (approx.)	29 kg
Environmental Requirements	Ambient temperature 5 - 40 °C
	Humidity range 5 - 90 %
Power Requirements for Smart Controller	24VDC (+/- 10%), 120W (5A)
Power Requirements for MotionBlox-60R	24VDC (± 10%), 150W (6A)
	200V to 240V AC, 1-phase, 50/60Hz

Camera System
SmartMove is based on the NDI Spectra™ camera system. This tracking hardware uses infrared light to track the position of the pointer or other tools. Each tool is equipped with multiple passive markers. The position and the orientation of the tools are inferred from the infrared light reflected back to the position sensor. Accuracy is guaranteed to be in the sub-mm range.

Accuracy	Pyramid: 0.25 mm RMS
AAK	0.35 mm RMS
95% Confidence Interval	Pyramid: 0.5 mm
Maximum Update Rate	60 Hz
Operating Temperature	10°C to 40°C
Measurement Volume	Pyramid
Data Communication Interface	USB
Power Requirements	100/120/220/240 V AC, 50/60 Hz, 0.5 A
Mounting	Tripod, wall or ceiling

Control unit
The control unit operates the robot arm, the optical tracking system and runs the software module.

External start / stop / pause control	TCP/IP (Ethernet-switch or 2nd Ethernet card required)
Computer	High performance PC with 2GB RAM, fast
	graphics card, 2x Ethernet card, COM-Port, USB2-Port
Operating System	Windows XP or Linux (Ubuntu)
Additional requirements	Java JRE 1.6, VTK 5.0.4

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