In Vitro Setup for Measurements of Temporal Interference Stimulation

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Temporal interference stimulation (TIS) is a growing field in various therapeutic applications. To verify simulated models of interfering electric fields a system is needed, which can measure generated potentials autonomous and with high space and time resolution. The measurement system that was evaluated, designed, manufactured and programmed in this thesis allows an efficient verification of promising new applications TIS.

Introduction

TIS is a promising alternative to functional electrical stimulation (FES), as it minimizes co-stimulation and reduces the infection risk in case of non-invasive application . There is no measuring equipment available at the BFH, which can measure the special and time variant properties of the generated electric fields precisely. The objective of this thesis is to design, manufacture, program and validate a measurement system, which can generate a TIS with two stimulation electrode pairs and measure the field with one automated measurement electrode pair.

Method

In the preliminary study the specifications of the measurement system were defined and the task was split into different packages. Each of the package is technically independent to simplify the process of finding a suitable technical concept. All possible concepts were evaluated and implemented into the final design, which met all input requirements. The system was manufactured and different software models and use cases were defined and implemented such that the measurement system can be used for various scenarios.

3D rendering of the TIS measurement system

Result

The final measurement setup contains two automated moving axes, which use stepper motors as actuators and threaded rods with small paces to transfer the movement of the motor precisely to the measurement electrode pair. At the end of each axis a light barrier is placed to determine the operation range of the measurement electrode. Encoders on each of the stepper motor are responsible for the correct spatial placement of the measurement electrode. To simplify and guarantee the precise placement of the stimulation electrode pairs, pre-built linear tables in two axis and a rotary stage were used. With calculations of the spacial tolerance and the required motor torque the system was verified to satisfy the input requirements. Two main use cases, „Manual“ and „Automatic“, were defined and implemented into the software with a state machine. In the „Automatic“ mode measurement points can be defined via Matlab-Script, which will generate an efficient moving path for the measurement electrode pair around the stimulation electrode pairs. The generated points can be sent to the system with an UART interface on the computer. The system automatically drives to a defined point, measures and retrieves the data. If the system is ready the next point will be targeted automatically. In the „Manual“ mode the measurement electrode pair can be controlled with a virtual joystick. The software was implemented in Simulink (Mathworks,USA) and runs on a MicroLabBox (dSpace, Germany).

Outlook

Next the manufactured system has to be assembled and the software has been tested on the physical setup. The calculated spatial tolerance of the measurement electrode pair will be verified with measurements on the real setup. Additionally, defined test scenarios for the software have to be conducted to

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