Design and validation of neural electrical impedance tomography system for detection of fast neural activity by evoked response in a rat brain cortex

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Electrical impedance tomography (EIT) has a potential to be used to visualize fast neural activity in the brain with a temporal resolution of milliseconds. Recently, fast neural EIT images by evoked responses in a rat brain cortex were produced by using an epicortical planar 29 electrode array. The aim of this study was to design and validate neural EIT system with 128 electrodes for extending imaging to the entire rat brain. The current source was designed as a floating single-ended source with 128 channel switching network with a medically isolated power supply. Sinusoidal or pulse waveform with maximum 254 μA root-mean-square (μA_{RMS}) can be injected from 2 Hz to 2 kHz. The current waveform is generated in digital waveform generator implemented in a field programmable gate array and then converted from voltage to current by an improved Howland current pump. The output impedance was over 4 MΩ below 1 kHz and 1.2 MΩ at 1.2 kHz. The amplitude stability and total harmonic distortion were less than 0.76 % and 0.0002 % in the operating ranges respectively. The linearity error with 7.14-71.43 μA_{RMS} current injection at 225 Hz was less than 0.8 % across load 4-10kΩ. Currently the newly designed current source is being coupled with a commercially available high density EEG system to provide recording of generated voltages. The next stage of this study will be to produce fast neural activity changes in the entire rat brain.