A soft housing ultrasonic needle transducer delivers focalized brain stimulations in mouse barrel and visual cortex

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Conventional acoustic brain stimulators which transmit low frequency (<1 MHz) in a pulse repetition frequency with large-sized transducers are barely compatible with small animal models. A miniaturized ultrasound stimulator having higher stimulation frequencies will enhance spatial specificities and enable concomitant modulation and monitoring brain activities. Also, the use of non-periodic pulse sequences may reduce unintended stimulations on auditory cortex which was reported to be caused by transmitting periodic patterns. A platform for ultrasound brain stimulations for small animal models including a soft housing 10 MHz needle transducer having a beam size of 680 μm, random transmission sequences and optical imaging systems was developed. The platform can deliver focalized stimulations on visual and barrel cortex of mice and monitor the brain activities. The stimulated sites of both visual and barrel cortexes showed about two to three times higher cerebral blood volume changes and neuronal calcium signal levels than the ones from peripheral regions. In the peripheral regions, consistent response patterns could be identified from five mice. The excitation and inhibition of motor cortex could be visualized by stimulating somatosensory and visual cortex, respectively. The activities at auditory cortex were elicited by periodic sequences while those are reduced vy using random sequences.