Docket #: S16-382

Ultrasonic neuromodulation with Pattern Interference Radiation Force (PIRF)

Stanford researchers have designed a non-invasive, low power ultrasonic neuromodulation device which can target tissue deep in the brain with high spatial-temporal resolution. Current technologies such as conventional electrical stimulation are invasive requiring surgery and non-invasive methods such as TMS (Transcranial Magnetic Stimulation) and tDCS (transcranial Direct Current Stimulation) cannot target tissue deep in the brain and have poor spatial-temporal resolution.

This unique design which we call PIRF (Pattern Interference Radiation Force), in it's simplest form, situates two transducers opposed to one another such that the resulting interference pattern forms a standing wave which in some circumstances could stimulate or inhibit neural tissue with far less energy and better spatial resolution than conventional single transducers. The goal of this invention is to optimize ultrasonic neurostimulation to translate this technology from a research tool to a versatile clinical application.

Stage of Research

- Preliminary *in vivo and ex vivo* animal data
- Validating that technique is optimal

Applications

- **Ultrasonic neurostimulation** for medical conditions such as depression, Parkinson's, tremor, dystonia, epilepsy, and pain management
- Can be used for any part of the nervous system, central or peripheral, including all sensory systems
- **Research**- stimulating neurons in vivo, ex vivo and in vitro preparations

Advantages

- **Non-invasive** - compared to conventional electrical stimulation which require surgical implantation of electrodes in close proximity to the target volume
- **Reduced risks and costs** since no surgery is involved
- **High spatial resolution** - as compared to TMS and tDCS
- **Can target deep into brain** - unlike TMS and tDCS
- **Efficient**- provides maximum neural stimulation at minimal intensity
- **Low-power** focused ultrasound
- **Employs two transducers** opposed to one another such that the resulting interference pattern is optimal for stimulation. Current conventional ultrasound neurostimulators use one transducer
- **Tunable for optimized therapy** - offers multiple modes of ultrasonic neuro-stimulation with the same hardware which allows clinician to test various therapies

Publications

- M.D. Menz, P. Ye, K. Firouzi, A. Nikoozadeh, K.B . Pauly, P. Khuri-Yakub and S.A. Baccus Radiation Force as a Physical Mechanism for Ultrasonic Neurostimulation of the Ex Vivo Retina *Journal of Neuroscience* August 7, 2019, 39 (32) 6251-6264.
- Menz, Mike D., Patrick Ye, Kamyar Firouzi, Kim Butts Pauly, Butrus T. Khuri-Yakub, and Stephen A. Baccus. Physical mechanisms of ultrasonic neurostimulation of the retina *bioRxiv* (2017): 231449.

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