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Ultrasonic Neuromodulation with High Spatial Resolution Chirp Waveform Pattern Interference Radiation Force (PIRF) (combined with 16-382)

Stanford researchers from the Khuri-Yakub group have designed an improved, high spatial resolution ultrasonic neuromodulation device that implements chip waveform instead of continuous wave PIRF. Ultrasound neuromodulation using one or two transducers have been designed previously, but high pressure needs to be applied to achieve stronger modulation, causing tissue damage due to cavitation. The Khuri-Yakub group designed PIRF, which maximize radiation force by situating two transducers oppose from one another to generate a standing wave that can stimulate neural tissues with far less energy. However, this method still has limited spatial resolution, and the position of the target or the transducer need to be moved mechanically to modulate a different area.

The group has therefore developed an improved PIRF system using a chirp waveform in which the frequency changes with time instead of a single waveform. Chirp excitation remarkably reduces the size of stimulation spot and allows for high spatial regulation. In addition, the modulation spot can be moved electronically rather than mechanically by correcting in proportion to time delays, which decrease the technical barriers associated with current neuromodulation methods. This new neuromodulation device can be readily implemented into current medical equipment as well as other fields where ultrasonic stimulation is required.

Applications

- Medical equipment for neuromodulation and nerve stimulation for various disorders such as Parkinson's, Tourette syndrome and epilepsy
- Ultrasonic stimulation of other parts of the body where spatial resolution is required
- Other fields where acoustic radiation force (ARF) is used (ex. particle manipulation, acoustic tweezers, etc)
- Implementation of PIRF with chirp waveform into general focused transducers

Advantages

- Greater radiation force with the same acoustic pressure
- Reduced damage caused by heat and cavitation from pressure
- Reduced stimulation spot size with chirp waveform
- Improved spatial resolution with chirp waveform compared to the previous generation PIRF
- Precise movement of modulation spot inside the body electrically
- Easy implementation into existing transducers by changing the input signal to chirp waveform

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