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Dual-mode Ultrasound Array (DMUA) Systems for Noninvasive Surgery

John Ballard, Yayun Wan and Emad Ebbini
University of Minnesota, 200 Union St SE, Rm 4-174 EECS Bldg, Minneapolis, MN 55455, USA

Advances in microelectronics and piezocomposite transducer technology have made it possible to design, fabricate and test therapeutic arrays with imaging capabilities suitable for image-guided noninvasive surgery. Prototype DMUAs have been recently tested and were shown to be capable of generating therapeutic HIFU beams suitable for tissue ablation while intermittently imaging the target volume before, during and after lesion formation. An additional advantage of imaging with DMUAs is the potential for identifying critical regions in the treatment field for targeting or avoidance by the HIFU beam. We have developed an image-based refocusing algorithm that allows for maximizing the power deposition at the location of HIFU focus while minimizing the power deposition at critical targets to be avoided. Grayscale images obtained using the DMUA are used to define the coordinate of the target and the grid points in the treatment region. A major application of this capability is the targeting of liver tumors by large-aperture arrays in the presence of the rib cage. In this paper, we present experimental validation of this algorithm in vitro. Quantitative analysis of the improvements in the quality of the HIFU beam at the target will be presented and discussed.