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Dynamical focusing method for high-intensity ultrasound applications

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New method for direct synthesis of dynamically focused acoustic field suitable for HIFU applications is proposed. The method is based on the continuous cyclic generation of different focal patterns at optimal repetition frequency by simultaneous applying of "M" different frequency signals to "N" sectors of spherically shaped sectored transducer array. The HIFU transducer arrays comprising a spherical piezoceramic cap with back electrode divided circumferentially into "N" regular or specially shaped sectors were designed and tested. The sectors were simultaneously powered by "M" ($M \leq N$) sinus or burst drive signals with different frequencies from 6 dB bandwidth of the transducer. Calculation and modeling of acoustic field patterns for different array configurations and frequencies sets were performed. Acoustic pressure in focal planes was measured in water using calibrated hydrophone and 3D acoustic scanning system. In vitro experiments on different tissues confirming the advantages of dynamical focusing method were performed. The benefits of the method are creating bigger treated tissue volumes and enhancement of the cavitation, mechanical or thermal influences due to coincidence of the repetition frequency with a specific resonance/relaxation times for tissue and/or for cavitation "cloud". Applications of the method for ultrasonic therapy, hyperthermia, and body aesthetics were considered.