35 MHz Coherent Plane Wave Compounding High Frequency Ultrasound Imaging

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Abstract : Ultrasound transient elastography has become a valuable tool for many clinical diagnoses, such as liver diseases and breast cancer. The pathological tissue can be distinguished by elastography due to its stiffness is different from surrounding normal tissues. An ultrafast frame rate of ultrasound imaging is needed for transient elastography modality. The elastography obtained in the ultrafast system suffers from a low quality for resolution, and affects the robustness of the transient elastography. In order to overcome these problems, a coherent plane wave compounding technique has been proposed for conventional ultrasound system which the operating frequency is around 3-15 MHz. The purpose of this study is to develop a novel beamforming technique for high frequency ultrasound coherent plane-wave compounding imaging and the simulated results will provide the standards for hardware developments. Plane-wave compounding imaging produces a series of low-resolution images, which fires whole elements of an array transducer in one shot with different inclination angles and receives the echoes by conventional beamforming, and compounds them coherently. Simulations of plane-wave compounding image and focused transmit image were performed using Field II. All images were produced by point spread functions (PSFs) and cyst phantoms with a 64-element linear array working at 35MHz center frequency, 55% bandwidth, and pitch of 0.05 mm. The F number is 1.55 in all the simulations. The simulated results of PSFs and cyst phantom which were obtained using single, 17, 43 angles plane wave transmission (angle of each plane wave is separated by 0.75 degree), and focused transmission. The resolution and contrast of image were improved with the number of angles of firing plane wave. The lateral resolutions for different methods were measured by -10 dB lateral beam width. Comparison of the plane-wave compounding image and focused transmit image, both images exhibited the same lateral resolution of 70 um as 37 angles were performed. The lateral resolution can reach 55 um as the plane-wave was compounded 47 angles. All the results show the potential of using high-frequency plane-wave compound imaging for realizing the elastic properties of the microstructure tissue, such as eye, skin and vessel walls in the future.

Keywords : plane wave imaging, high frequency ultrasound, elastography, beamforming
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