Spatial Encoding Using a Code Division Technique for Fast Ultrasound Imaging

This paper describes a method for spatial encoding in synthetic transmit aperture ultrasound imaging. This allows several ultrasonic sources to be active simultaneously. The method is based on transmitting pseudo-random sequences to spatially encode the transmitters. The data can be decoded after only one transmission using the knowledge of the transmitted code sequences as opposed to other spatial encoding techniques, such as Hadamard or Golay encoding. This makes the method less sensitive to motion, and data can be acquired using fewer transmissions. The aim of this paper is to analyze the underlying theory and to test the feasibility in a physical system. The method has been evaluated in simulations using Field II in which the point-spread functions were simulated for different depths for a 7 MHz linear array transducer. A signal-to-noise ratio (SNR) simulation also was included in the study in which an improvement in SNR of \(\sim 1.5\) dB was attained compared to the standard synthetic transmit aperture (STA) firing scheme. Considering the amount of energy transmitted, this value is low. A plausible explanation is given that is verified in simulation. The method also was tested in an experimental ultrasound scanner and compared to a synthetic transmit aperture ultrasound imaging scheme using a sinusoidal excitation. The performance of the proposed method was comparable to the reference with respect to axial and lateral resolution, but it displayed poorer contrast with sidelobe levels at \(\sim 40\) dB compared to the mainlobe.
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