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Signal to noise ratio improvement in coded excitation medical ultrasound imaging in the presence of frequency dependent attenuation

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Abstract

Coded excitation is one of the important methods to increase medical ultrasound imaging depth. Commonly match filters are used to retain the axial resolution of ultrasound images in this type of excitation. Frequency dependent attenuation in the propagation medium of ultrasound wave, degrades the pulse compression performance of matched filter in coded excitation ultrasound imaging. In this paper fractional Fourier transform is proposed as an alternative method for pulse compression in high attenuating medium. Additionally a chirp signal detector is proposed in fractional domain in order to detect the echo signals and compare the performance of matched filter and fractional Fourier transform quantitatively. The comparison of this two methods shows that signal to noise ratio of fractional Fourier transform output is more than that of matched filter in deep parts in which ultrasound wave faces high level of attenuation. Simulation results show that pulse compression with fractional Fourier transform is less sensitive to frequency dependent attenuation. In other words, in the presence of frequency dependent attenuation, the detection probability of echo signal in fractional domain is more than that of match filter. The amount of improvement in the proposed method depends on the imaging depth and the value of attenuation in the medium. In other words, the more the imaging depth the more improvement is achieved by the propose method. Finally using Wigner-Ville time-frequency representation we consider the reason of better performance of fractional Fourier transform over matched filter.

Keywords: Fractional Fourier transform, Matched filter, Pulse compression, Coded excitation, Medical ultrasound imaging.

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