A MULTI-GATE PULSED DOPPLER SYSTEM WITH AUTOMATIC CORRECTION FOR FREQUENCY-ALIASING

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Multi-gate pulsed Doppler systems allow the transcutaneous assessment of the velocity-distribution along the ultrasound beam i.e. the simultaneous detection of the velocity as function of time in a number of adjacent sample volumes. Because of resolution requirements the sample volume should be made as small as possible. For peripheral applications this can result in 10 to 20 sample volumes covering the cross-section of an artery. Because of the large number of sample volumes involved it is impractical to perform audio-evaluation for each of the sample volumes. The decision whether the blood flow is (locally) disturbed due to wall irregularities or stenoses or even turbulent has to be made on the base of the temporal and spatial behaviour of the velocity profile. It is, therefore, essential that the procedure to estimate the average Doppler frequency, reflecting the average velocity, functions properly over a wide range of frequencies and under poor signal-to-noise conditions. This paper will deal with an algorithm satisfying these prerequisites. Computer simulations demonstrated that the present approach results in accurate estimates of the average Doppler frequency over a wide range of signal-to-noise ratios. For a signal bandwidth of 0.2 of the PRF, and a theoretical average frequency of 0.2 of the PRF the fractional error is less than 2% for a signal-to-noise ratio of 0 dB. The algorithm allows the tracking of the average frequency beyond the Nyquist-frequency (PRF/2) provided that the frequency-range of the Doppler signal is limited to PRF. The estimation procedure is implemented in a 64 channel pulsed Doppler system operating at an emission frequency of 6.1 MHz. The sample volumes are spaced at intervals of 0.5 mm along the ultrasound beam covering a range of 32 mm. Data-processing within the system is on a digital base ensuring that the signals from each of the sample volumes are processed in a similar way.