Advances in pulsed Doppler methods for peripheral perfusion imaging

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Temporal sampling can be designed to strategically add new data-array dimensions. In this manner, the sensitivity of pulsed Doppler acquisitions to a broad range of blood velocities is increased without exogenous contrast enhancement. Clutter filtering is applied to a basis decomposition of the full data array to separate blood and clutter echoes before projecting the data onto the blood subspace and computing a mean Doppler frequency or net echo power for any range of velocities. Our methods significantly increase acquisition sensitivity to blood echo velocities > 2 mm/s (flows between 1-4 ml/min) at pulse frequencies between 5-24 MHz, thus enabling simultaneous arterial and peripheral-perfusion imaging. The cost is a lengthy 1-10 s data acquisition time, which is acceptable for stationary blood-echo signals in the periphery. These methods were tested on commercial instruments applied to an ischemic mouse model where perfusion was predictably modified over time using independent imaging methods. Examples of tumor perfusion imaging show that power Doppler images with some velocity discrimination are readily achievable.