Optical Coherence Tomography flow detection using Speckle Variance analysis

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Optical Coherence Tomography (OCT) is a noninvasive imaging modality with high resolution. However, the OCT is sensitive to speckle noise, which influences negatively on the resolution of the system. Nevertheless, the speckle decorrelation between frames may be used to detect flow movement on the sample, a technique called Speckle Variance, that is important to detect microcirculation in vivo. The objective of this work was to evaluate the sensitivity of Speckle Variance and it's relation to flow velocity. To achieve that we performed simulations by software, on which we assumed an acquisition rate of 6 frames per second and a spatial resolution of 3 μm per pixel, but these values are customizable. The variance was calculated over 100 frames for each simulation. The simulations consist of three parts. On the first one we generated frames, with dimensions of 500 X 500 pixels, consisting of background white noise, with variable maximum intensity, defined via user input. That noise pattern changes in each frame. In the frame center, a square region of 50 x 50 pixels was selected as the signal, and random pixels with maximum intensity were translated to the right circularly, simulating a flow region with customizable velocity (μm/s) in that area. The next step was to calculate the variance between those frames, normalizing the variance values to 0-254. Those first two steps were repeated for various combinations of background noise and velocity of the signal pixels, generating one variance image for each in order to study its dependence. The last step was to calculate the visibility of the detected signal in respect to the background. That was done computing the sum of the intensities on the region of signal and subtracting from it the sum of the intensities of the background. Those visibilities values were plotted in function of Background Noise Level (for specific velocities), also Velocity (for specific background noise levels) and a 3D surface graph, correlating all three variables - Visibility, Velocity and Background Noise. We found that for values lower than 0.025 for visibility, the signal is no longer distinguishable from the background. These methodology developed in this work will be used for microflow characterization either in microfluidics and microcirculation.