ABSTRACT

H-scan imaging is an ultrasound technique that can be used to characterize tissues. In H-scan imaging, ultrasound radiofrequency (RF) echoes from tissues are matched to the Gaussian Hermite polynomial of order n. The convolution of the RF data with the Hermite polynomial extracts frequency-dependent information, which is related to the size of tissue scatterers. This information is used to characterize tissue structures based on color-mapping large scatterers in the red channel and small scatterers in the blue channel of the H-scan image. This research aimed to evaluate H-scan imaging on a breast tumor dataset and tissue-mimicking phantoms of different acoustic scatterer sizes and concentrations. H-scan imaging was implemented on a publicly-available ultrasound RF dataset of 100 breast tumors. H-scan imaging of benign and malignant tumors depicted a significant difference ($p<0.05$) in the red and blue channel components, demonstrating the ability of H-scan imaging to differentiate between tumor types. Furthermore, polyvinyl alcohol hydrogel phantoms with different mean sizes of silicon carbide (SiC) particles (16, 30, 39, and 74 μm) at varying concentrations (0.25, 0.5, 1, 2, 4, and 6% w/v) were analyzed to establish a groundwork for further studies of the technique. Comparing between phantoms with 16 and 30 μm SiC particles, no significant differences in the percentages of red and blue channels of H-scan images were observed for all SiC particle concentrations. In contrast, significant differences in these H-scan parameters were observed ($p < 0.0001$) between phantoms with 30, 39, and 74 μm SiC particles. For phantoms with small particles (16 and 30 μm sizes) at low concentrations (0.25%, 0.5%, and 1% w/v), no significant differences in the percentages of red and blue channel components were observed. However, for the larger particles (39 and 74 μm sizes) and at higher concentrations (2%, 4%, and 6% w/v), significant differences in these H-scan parameters were observed ($p < 0.0001$). Taken together, H-scan imaging can differentiate between a range of scattering particle sizes and has no dependence on particle concentration at relatively low concentrations under the weak scattering regime.

Keywords: Ultrasound imaging, H-scan, Breast tumors, Polyvinyl alcohol phantoms