The Bead Phantom

Object variability plays a crucial role in the objective evaluation of an imaging system. However, measured variable backgrounds are difficult to obtain, particularly in the small-animal imaging realm where extensive patient data do not exist. The bead phantom, shown in Figure 1(a), is capable of producing multiple realizations of a random, textured background. The phantom consists of a solid plexiglass base upon which a hollow plexiglass cylinder has been bonded. To generate random backgrounds, the phantom is loaded with non-uniform, ellipsoidal polystyrene beads. The negative space surrounding the beads is filled with a dilute radioactive solution, and tomographic data are acquired. The beads are then stirred to create the next realization of the background. Slices through two example bead-phantom reconstructions are presented in Figure 1(b)-(c).

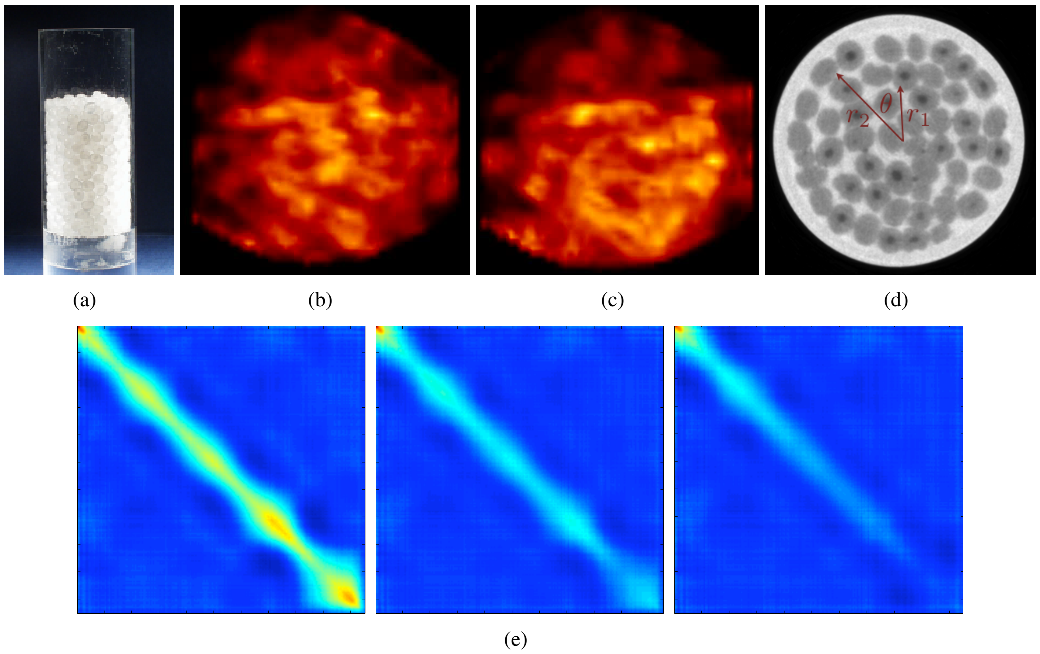

Figure 1: (a) The bead phantom. (b)-(c) Slices from bead-phantom reconstructions. (d) Example CT slice from the bead phantom. CT data were used to calculate bead-phantom covariance matrices. (e) Bead-phantom covariance as a function of radial distance and angle for $\theta = 0°, 4°,$ and $8°$.

The bead phantom has been successfully employed in a signal-detection study examining observer performance as a function of exposure time in a variety of background types [1]. We also desired methods for analytically computing bead phantom covariance expressions similar to those methods previously developed for the lumpy background. We were able to use measured CT data (acquired on the dual-modality system) and take advantage of the radial symmetry of the bead phantom to successfully evaluate the covariance between any two points as a function of radial distance and angle as illustrated in Figure 1(d) [2]. Covariance matrix values as a function of r_1 and r_2 are displayed for $\theta = 0°, 4°,$ and $8°$ in Figure 1(e).

References

[1] J. Y. Hesterman, M. A. Kupinski, E. Clarkson, and H. H. Barrett, Hardware assessment using the multi-module, multi-resolution system (M^3R) - A signal-detection study, *Medical Physics* , 2007 (Tentatively Accepted).

[2] J. Y. Hesterman, The multi-module, multi-resolution SPECT system: A tool for variable-pinhole, small-animal imaging. Ph.D. Dissertation, University of Arizona, 2007.