AbstractID: 14013 Title: A method to construct synthetic maps of spatially correlated deformable image registration errors by random sampling of de-correlated error modes

Purpose: To develop and test a method for constructing random synthetic maps of spatially correlated deformable image registration errors for estimating uncertainties in daily dose summation.
Method and Materials: Two CTs were deformably registered 50 times using a variable region of interest (ROI) as the target of the registration. The displacement vector fields (DVFs) for anatomic motion included spatially correlated errors due to the variable ROI. Maps of the DVF error were created by subtracting the mean DVF from the individual DVFs for the volume shared by all ROIs. These DVF error maps were used as a training set to which principal components analysis was applied, producing spatially de-correlated modes of DVF error. These modes were sampled independently and used to reconstruct new synthetic maps of DVF error that reproduced the characteristics of the training set.
Results: We applied three tests to show that a set of our sampled DVF error maps was statistically indistinguishable from a set of validation error maps: (1) the standard deviation of the sampled DVF errors was comparable to that of the validation set; (2) the eigenvalue spectra were the same for the sampled and validation sets; (3) the Kolmogorov-Smirnov test applied to the principal coefficient distributions for the two sets was consistent with their indistinguishability.
Conclusion: We have developed a method to construct DVF error maps by sampling probability distributions of the spatially de-correlated error modes. We validated our procedure by demonstrating that maps of DVF error produced by our method were statistically indistinguishable from validation error maps. We propose to use this method to calculate the effect of DVF error on daily dose summation using deformable image registration.