AbstractID: 13963 Title: Demonstration of the Ability to Morph an Existing Whole-body Phantom to a Different Individual

Purpose: Although patient-specific partial-body phantoms can be created from CT data, whole-body phantoms are desired for the assessment of organ doses in CT, internal nuclear medicine and external-beam radiation treatment procedures. This study proposes an innovative strategy for developing patient-specific whole-body phantoms by morphing a pair of deformable phantoms. Adjustments were made to the original data to make these phantoms compatible with anatomical parameters and the tissue/organ surfaces matching the values specified by patient-specific image data.

Method and Materials: In order to match tissue/organ surfaces to the patient-specific data, three different adjustment approaches to the mesh deformation are considered as follows: (1) uniform scale factor adjustment: displacement of each vertex point by a uniform scale factor in relation to the organ centroid; (2) unique scalar factor adjustment: translation of each vertex point along the direction of vertex normals by a unique scalar factor; (3) mesh-based deformation: tracking of mesh surface geometry by a union of direction vectors at the center of each vertex of the polygon mesh surfaces using ray casting algorithm. This approach is mainly used for deforming the primary organ meshes to patient-specific organs collected from scanned image data through the general radiological modalities. The new mesh-based phantoms need to be converted to voxels with correct tissue density and elemental composition information for Monte Carlo dose calculations.

Results: The final organ volume and mass values of the RPI patient-specific phantoms in mesh representation have an acceptable relative error, less than 0.5%, according to the acceptance criteria in mesh deformation algorithms. To accomplish acceptable results, several iterations were required for some of the internal organs.

Conclusion: This study has demonstrated patient-specific computational phantom modeling methods with the feasibility of the size-adjustable RPI-AM and RPI-AF base phantoms. The anatomical details were accurately and consistently persevered through this approach.