

This presentation looks at infrastructure needed for research investigation and for routine clinical use of time resolved volumetric (4D) image guided therapy. The 4D imaging data used for IGRT comes from a variety of sources ranging from standard CT scanners, cone-beam CT from gantry mounted imagers, MR, and PET images. An example of a reconstructed 4-D data set for CT would have dimensions (512x512x100x10) (100 slices per volume representing 10 different time intervals). This represents approximately 0.5 gigabytes of data. Daily acquisition of these images therefore represents significant storage demands and increased network speeds needed to communicate this data between various processes (image alignment tools, contouring/segmentation, and treatment planning). While the DICOM imaging standard can be used for storing 4D datasets, the related derive data such as deformable alignment parameters and other associated data such as statistics about anatomical variability and embedded marker positions, are beyond the standard and require establishment of separate bookkeeping to maintain that data. The actual use of 4D data varies. This data provides information about patient alignment and extent of physiological motion. However, 4D data can also provide time dependent functional information which may provide early indicators of tumor and normal tissue responses. Decision based on analysis of these functions can be employed for daily assessment and immediate adjustments to the treatment either before or during delivery. Or analysis of the 4D data may be used to provide statistical support for more deliberate plan adjustment decisions. Often 4D data implies geometrical changes over time such

as heart and respiratory motion which require deformable alignment of image volumes to relate and track anatomical regions of interest between different motion states and in reference to the imaging volumes used for planning.

. To aid in this presentation, a survey of current research and clinical uses of 4D image guided therapy will be presented with answers to questions regarding : the types of 4D imaging data sets used, the sizes of typical data sets, the frequency of acquisition, storage demands (long term and short term) and algorithms used for reconstruction, registration, analysis, and compression. The survey results demonstrate infrastructure needs for 4D image guided therapy that are significantly above and beyond what is typically needed for static volumetric imaging and planning in terms of both the amounts of data acquired and the tools needed for data management and analysis, This survey has included manufacturers and leading researchers in the field. In addition to survey results, examples of the infrastructure implemented by these users will be shown.

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Educational Objectives:

1. Identify various sources of 4D data and typical storage requirements
2. Present various use of 4D for IGRT employed to date and associated data display and analysis tools
3. Demonstrate successful infrastructure implementations