

Purpose: The proposed work focuses on addressing the impact with which the patient's treatment delivery can be monitored and documented in real time taking into account the interfraction and intrafraction motion and effective optimizations for the treatment can be conceived and implemented. The first step towards establishing the radiation delivered to the head and neck tumor and the surrounding tissues in real-time is the development of subject specific biomechanical head and neck models. The complexity in developing such a biomechanical model arises from the human musculoskeletal system, which includes approximately 57 articular bones and many more muscle actuators and their closed kinematic loops.

Methods: We present a subject specific model, which is developed using cancer patients' 3D CT scans (simulation CT, cone-beam CT), a validated generic biomechanical model and registration algorithms that incorporate biomechanical properties from the generic model into the static patient anatomy to facilitate subject-specific biomechanical model. For illustration purposes, we take as input a subject specific anatomy from a 3DCT acquired during the simulation stage. For analysis purposes, free-form deformation (FFD), demons, the symmetric force demons, and optical flow (OF) registration methods are used within the multi-level multi-resolution (MLMR) and additional Inverse Consistency (MLMRIC) for comparing the registration accuracy. Once registered, the biomechanical generic model is warped using the registration results to closely fit the patient anatomy thereby facilitating a patient specific biomechanical model.

Results: Validation studies showed that among the eight 3D registration methods, the MLMR symmetric demons registration is quantitatively more accurate as compared to the other methods and facilitates the development of a more appropriate subject specific biomechanical head and neck model.

Conclusions: The development of subject specific biomechanical models is made possible by MLMR symmetric demons registration of generic validated biomechanical models to subject anatomy.