# AbstractID: 12984 Title: A Laplacian Surface Deformation and Optimization based 3D Registration Algorithm for Image Guided Prostate Radiotherapy

**Purpose:** To develop a fast landmarks based deformable registration method to capture the soft tissue transformation between the planning 3D CT images and treatment 3D cone-beam CT (CBCT) images for the adaptive external beam radiotherapy (EBRT).

**Method and Materials**: The developed method was based on a global-to-local landmarks based deformable registration algorithm. The landmarks were first acquired by applying a fast segmentation method using active shape model. The global registration method was applied to establish a registration framework. The Laplacian surface deformation (LSD) and Laplacian surface optimization (LSO) method were then employed for local deformation and remeshing respectively to reach an optimal registration solution. In LSD, the deformed mesh is generated by minimizing the quadratic energy to keep the shape and to move control points to the target position. In LSO, a mesh is reconstructed by minimizing the quadratic energy to smooth the object by minimizing the difference while keeping the landmarks unchanged. The method was applied on 6 EBRT prostate datasets. The distance and volume based estimators were used to evaluate the results. The target volumes delineated by physicians were used as gold standards in the evaluation.

**Results:** The entire segmentation and registration processing time was within 1 minute for all the datasets. The mean distance estimators ranged from 0.43 mm to 2.23 mm for the corresponding model points between the treatment CBCT images and the registered planning images. The mean overlap ratio ranged from 84.5% to 93.6% of the prostate volumes after registration. These results demonstrated reasonably good agreement between the developed method and the gold standards.

**Conclusions:** A novel and fast landmarks based deformable registration method is developed to capture the soft tissue transformation between the planning and treatment images. The preliminary results show that the method has the potential to be applied to real-time adaptive radiotherapy.