

AbstractID: 7026 Title: An Open-source radiotherapy image registration toolkit integrated with CERR

Purpose: We developed an image registration module for the open-source system CERR (the computational environment for radiotherapy research) for the purpose of radiation therapy image guidance quality assurance and image analysis. This new module provides functionality useful for registration algorithm optimization, visualization, analysis, and validation.

Method and Materials: We implemented a series of automatic (rigid and deformable) and semi-automatic image registration methods. We implemented 20+ original and variant deformable methods, including optical flow based methods with different constraints, level set motion based methods and demon based methods. We imported ITK rigid image registration methods into CERR, including affine transform, similarity transform, Euler3D transform, versor3D transform, etc. We also implemented a multi-grid framework to improve the speed and accuracy of the automatic registration process. In addition, we implemented 3D control point matching methods. We use several similarity metrics, including MSE, cross correlation, MI etc., to quantitatively analyze and validate the registration results. For results visualization, we implemented functions such as difference, dynamic checkerboard, image mirror, deformation field vector and grid plotting, etc. We programmed the GUI in MATLAB and Java, deformable methods in MATLAB and ITK rigid registration methods in C++.

Results: The new CERR module supports 3D rigid and deformable registration. By monitoring the registration process and measuring the results, we can optimize the registration methods by tuning the parameters. We tested the deformable methods with chest CT images and the results were satisfied.

Conclusion: The goal of this work is to extend the functions of CERR, to provide an open source implementation of image registration algorithms for radiotherapy research. As an ongoing project, we plan to provide more registration methods and further improve the integration of the registration results with treatment planning data.