AbstractID: 3816 Title: A variational deformable image registration method capable of handling large organ deformation

Purpose:
The goal of this research is to develop an accurate and reliable deformable image registration algorithm capable of handling large organ deformations for mapping daily CT images to the reference planning CT.

Method and Materials:
We previously developed a diffusion-based deformable image registration algorithm using Thirion's "demons" algorithm. However, this implementation did not work well when large deformations occurred. In this study, we proposed a variational approach for deformable image registration within a multigrid computational framework. The differences of the two images were measured and minimized, and a regularization term was introduced to rule out discontinuities and other irregular solutions. In our numerical implementation, the well-studied multigrid method was used for solving the nonlinear Euler-Lagrange partial differential equation (PDE). In this multigrid approach, the results from the previous deformation field were used to initialize the next stage of deformation. Different smoothing parameters were also used at different stages. The solution to these PDEs gave the displacement fields which can be used to transform the daily CT images into the planning CT or vice versa. To test this approach, we performed deformable image registration using CT images of prostate cancer patients collected with an in-room CT-on-rails system under an IRB-approved protocol.

Results:
Daily CT images were selected for cases with severely distorted rectum (due to the presence of large bowl gas) or large variations in bladder filling. The results indicated that the proposed approach was capable of deforming very large shape changes of soft tissue or organ structures. Compared to the "demons" algorithm, the resulting registration was pronounced better visually and quantitatively using both distance and correlation measures.

Conclusion:
Our deformable registration approach demonstrated the capability of handling large deformations. Further validation studies need to be done to test its robustness.

Conflict of Interest (only if applicable):