Purpose: Automatic image intensity-based deformable registration algorithms will generally fail when large uniform intensity regions are involved between the reference and target images. Therefore, it is highly desirable to take advantage of prior anatomical information as additional constraint. The goal of this study was to implement a hybrid segmentation and intensity-based deformable image registration algorithm that to address the problem of correspondence ambiguity.

Method and Materials: The first step is for user to delineate volumes of interest (VOIs) either manually or automatically, without the need to create point-to-point correspondence. Subsequently, we calculate the 3D distance transformation of the surfaces of the corresponding VOIs. Then each voxel inside the ROI will be encoded and normalized to an intensity value by the distance transformation. Finally, these converted intensity values will replace the original intensity at the corresponding voxel locations. An in-house modified "Demons" algorithm was used to register the image intensity corrected image pairs. The resultant deformable transformation was used to propagate contours to validate the deformable registration. The correctness of the contours on the test images was reviewed to assess the improved accuracy of the new procedure.

Results: We found that difficult cases in which the original intensity-based registration failed had significant improvement not only for the segmented volume but also for the anatomy near the segmented volume. Examples of such case include a prostate case with large bladder deformation and cluttered image context; the registration accuracy was drastically improved near the user-defined surfaces without affecting normal registration for distant structures.

Conclusion: We have demonstrated that the procedure requires minimal user's intervention and is an effective method to incorporate prior knowledge in an image intensity-based deformable image registration scheme. This can be considered a hybrid method that combines a simple segmentation procedure within an automated registration process.