Purpose:To develop a contour-guided deformable image registration algorithm to improve the accuracy of deformation image registration in adaptive radiotherapy, especially for improving the accuracy of low contrast structures deformation.

Methods:We developed an efficient algorithm to accurately deform low-contrast structures in CT images. The new DIR algorithm is based on our original developed Demons algorithm by adding constraints defined by physician drawn contour pairs on images. By iteratively increasing the intensity of ROI enclosed by contour pairs, the optimization problem defined in Demons is ensured to converge to a desirable solution.

Results:The new algorithm was validated on both a numerical phantom experiment and a clinical patient case. For the digital phantom experiment, a moving image is defined as two intersected spheres embedded in a cube and the contrast between spheres and cube is low; and a target image is a low-contrast sphere in a cubic. For the clinical case, two CT images scanned for a head and neck cancer patient in one month apart are treated as a pair of moving and target images. The left parotids with anatomical changes are defined as structures of interest (SOIs). Qualitatively, with visual inspection, the proposed algorithm yields satisfactory results in both numerical and clinical testing cases. Quantitatively, root mean squares error (RMS) and normalized correlation coefficient (NCC) were calculated between the deformed and target SOI. Compared to the original Demons algorithm, the contour-guided Demons algorithm results the decrease of RMS and the increase of NCC for both cases.

Conclusions:The proposed contour-guided demons algorithm permits us to take advantage of the structures defined by physicians to obtain more accurate image deformations. It provides a useful clinical tool for future interactive adaptive radiotherapy.