Purpose: To determine the most accurate and practical algorithm for deformable image registration of 4DCT phase images of lung cancer patients.
Methods: The most widely used algorithm to implement deformable image registration for lung CT are the Demons (Thirion 1998) and the original H.S. optical flow (Horn & Scunck 1981) algorithms. Both are based on a differential approach that relies on information from image intensities and gradients. These two algorithms were developed in-house in MatLab and compared based on accuracy of registration on two carefully-selected patient lung 4DCT scans (i.e., small and large deformations). The accuracy was judged visually based on difference images before and after the registration, and on calculated mean-square-distance error (MSE).
Results: The results indicate that original H.S optical flow algorithm is more suitable for doing deformable image registration of thoracic CT to CT images. This is mainly due to faster computation time (up to 4 times faster) and slightly improved accuracy over the Demons algorithm; at least given the time constraint imposed by the number of iterations. Although MSE is not necessarily always an indicator of accuracy, it does back up our conclusions based on visual inspection of difference images. The difference in accuracy is due to the way the deformation vector field (DVF) smoothness is built in the optical flow vs. the Gaussian smoothness implementation in the Demons approach. Speed superiority of optical flow is due to the reduced number of re-sampling steps necessary while the Demons algorithm has to re-sample the deformed image at each iteration.
Conclusions: In most conventional implementations, the original Horn & Schunck optical flow algorithm is more practical and accurate than the Demons algorithm for doing deformable image registration on thoracic 4DCT images. Further work is necessary to confirm our results in other sites as well.