CHAPTER 6

Conclusions

6.1 The DIR accuracy on MVCT

The different deformation algorithms, transformation frameworks, and sequences of the target domain for generating the mapping direction affect the accuracy of DIR. Moreover, the accuracy of DIR depends on the ROI as well. The results are concordant between the accuracy in phantom and NPC cases for the known offset and the unknown offset investigations. The Horn and Schunck optical flow algorithm for both asymmetric and symmetric transformations, mostly show better performance for known and unknown offset investigation. The $SymHS_{FW}$ method shows the best agreement for rigid volume change with a mean of DSC = 0.899 ± 0.03 for phantom and 0.792 ± 0.07 for NPC patient images. Whereas, the $AsyDM_{FW}$ show the best performance for non-rigid volume changes with a mean of DSC = 0.812 ± 0.07 for NPC patient images. The best three DIR methods are the $SymHS_{FW}$, $AsyDM_{FW}$ and the $AsyHS_{FW}$. A comparison of DIR accuracy between kVCT and MVCT images reveals that they are not significantly different, based on intensity, volume, and physical characteristics of the deformation field. Although, the DIR on the kVCT images are significantly better than the DIR on the MVCT images in NMI analysis and DSC value in the rigid volume changes investigation, but the results of MVCT can yield the acceptable values. As regards the accuracy of DIR, the volume-based analysis demonstrated satisfactory volume matching for accumulated dose application with DSC values more than 0.7 for the best three methods and the validation in terms of intensity correlation, and deformation field analysis demonstrates clinically useful methods for adaptive radiotherapy applications.

6.2 The accumulated dose evaluation

The delivered dose differences from initial planned dose tended to increase as the treatment progressed. The target dose, receives a slightly different result from the initial plan at the end of the treatment. For the bilateral parotid glands, the discrepancy between the delivered and the planned mean doses is found to have increased by 6.8% (range: 2.2 to 10.9%) for the right parotid and by 15.2% (range: -1.7 to 36.3%) for the left parotid. The average mean parotid dose increase in the ranges of 2.24 ± 0.97 Gy (right) and 5.70 ± 4.12 Gy (left) at the end of the treatment. The mean parotid dose variations are significantly different from the initial plan after 6 weeks (right) and 5 weeks (left) of the treatment, with p-value = 0.049 (right) and p-value = 0.010 (left). The spinal cord does receives increase by 6.4% (range: -1.6 to 13.2%) from the initial plan, with the average near-maximum dose increasing in the range of 1.83 ± 1.5 Gy at the end of the treatment.

There is concordant between the accuracy of structure deformation and discrepancy of dose accumulation. The DIR method that yields the highest DSC value is considered the best method for dose accumulation with the lowest variation from the reference dose. As regards the uncertainty of dose accumulation, the three DIR methods demonstrate satisfactory volume matching for accumulated dose application with DSC values more than 0.7 for all the methods. Moreover, the one-way ANOVA analysis demonstrates that there is no significant different between the three DIR methods as regards ROI deformation and dose accumulation. However, when uncertainty is considered in the estimation of the accumulated dose for all the DIR methods, the average of the DSC value of all the targets by the three DIR methods is 0.816 ± 0.02. The mean uncertainty for estimating the target dose is 0.21 ± 0.11 Gy (range: 0.06 to 0.32 Gy). Regarding the uncertainty of the parotid dose, the averages of the DSC values by the three DIR methods are 0.756 ± 0.01 (right) and 0.799 ± 0.01 (left). This shows that the mean uncertainty values for estimating the parotid dose are 1.99 ± 0.76 Gy (range: 0.42 to 2.12 Gy) for the right parotid and 1.19 ± 0.24 Gy (range: 0.72 to 1.18 Gy) for the left parotid. For the spinal cord, the average of the DSC values is 0.762± 0.03 Gy, while the mean uncertainty value for the estimated dose is 0.41 ± 0.04 Gy (range: 0.03 to 0.33 Gy).

The accuracy of DIR on MVCT images show clinically useful methods for adaptive applications based on the intensity-based, volume-based, and deformation field analysis. The accuracy of the DIR methods affects the estimation of dose accumulation on both the target dose and the normal organ dose. The DIR methods on MVCT images provide an adequate dose estimation technique for observation as a result of inter-fractional anatomic changes and are beneficial for adaptive treatment strategies.