Title: Building Deformation Error Histogram and Quality Assurance of Deformable Image Registration

Figure 1: Schematic process of Generating Truth data set from a real patient image sets. Utilizing two different image sets from a patient, we perform Deformable Image Registration (DIR) and generate a Deformation Vector Map (DVM) (R). Then we generate Image R’ using the Image T and the DVM (R). Then, we have the truth data set, Image R’ and T, and DVM (R).

Figure 2: To test DIR system, we utilize the truth data set. Although DVM (T) should be the same as DVM (R) without systematic error, DVM (T) is not equal to DVM (R) in reality. Difference between DVM (T) and DVM (R) is the systematic error amount in DIR system. A head and neck case was utilized to test. Color map represent the magnitude of the difference vector between the truth DVM (R) and the test DVM (T) in mm scale. This process can be repeated for CBCT-to-CBCT DIR.

Figure 3: We implemented an image generator which can simulate CBCT image set from a conventional CT image instead of using a real CBCT. This is because CBCT will degrade all truth data set because of the image quality. The degraded data is not usable for testing. This experiment simulates the use of CBCT image for planning during adaptive radiation therapy, which requires DIR between CT and CBCT.

Figure 4: Result Deformation Error Histogram (DEH) which is cumulative distributions of error in DVM per ROI. We can see the confidence range of errors in DVM using DEH graph. 95% confidence range of the DVM error for brain stem can be found at the 5% on the brain stem DEH curve, which is 1.9mm for this head and neck case.