Applications of Image Registration in Cancer Treatment Response Assessment

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Over the course of a patient's cancer therapy, treatment methods need to be carefully evaluated and adapted. This evaluation is performed via monitoring the tumors' size and biological properties over the course of treatment. Multiple images at different time intervals are acquired to track the disease progression. Image registration is a process that employs algorithms to align and compare the time-series images--both visually and quantitatively. While discrepancies in patient positioning between images may be eliminated using rigid algorithms, registration of soft tissues (e.g. tumor and organs) requires deformable algorithms. Although many algorithms have been developed, it is unclear which is the best for monitoring tumor deformation. To this end, we designed a benchmark experiment to identify the most reliable algorithms (Chapter 2) and investigated the sensitivity of PET/CT image quantification in solid tumors to various algorithms (Chapter 4-5). Moreover, treatment evaluation of bone-related diseases requires accurate registration of the human skeletons. However, neither rigid nor deformable algorithm can fully account for the global flexibility and the local rigidity of the skeleton. An algorithm for skeleton registration was developed (Chapter 3) and applied (Chapter 6) to match metastatic bone lesions over the time-series images.