Introduction

Inter-subject comparisons of Positron Emission Tomography (PET) data in mice are important for the statistical analysis of multisubject molecular imaging studies. Direct PET to PET registration is particularly challenging due to the limited anatomical information in these images. For studies in which PET/CT data are both acquired, we can instead perform inter-subject registration using the CT images (with contrast). By imaging the mice in a common chamber for both PET and CT a simple rigid registration based on maximizing mutual information is sufficient for the PET to CT alignment. For CT to CT registration, we employ a three stage registration algorithm. The resulting maps from the PET to CT and from CT to CT are then combined to register the two PET volumes. This framework provides a tool for analyzing group similarities and differences in anatomical and functional CT-PET data, as well as longitudinal studies, in which subjects do not need to be accurately positioned with respect to each other.

Inter-subject Registration

- We are interested in registration of two sets of inter-subject data with different modalities, such as PET, CT(optical).
- One set of the data could be a mouse atlas, which can give us additional information after registration.

Whole body cross subject CT-CT registration using harmonic mapping

We consider the two mice surface as two Riemannian manifolds: \( (M,g) \) and \( (N,h) \) and try to find a map: \( u : M \to N \), \( u \in C^\infty(M,N) \).

In the first stage, this surface correspondence is then extrapolated to the entire mouse volume using a mapping that minimizes the 3D harmonic energy [2]. These two steps normalize large scale structural differences in mouse volumes by aligning their surfaces and can therefore account for gross differences in the positioning of the two animals, for example by repositioning the limbs of one mouse to match those of the other.

In the second stage, the resulting maps from the two steps are then combined to register the two CT volumes.

As a third stage, this 3D mapping is refined using an inverse-consistent CT intensity-based registration. The resulting maps from the three stages are then combined to register the two CT volumes.

Result

- We applied the proposed registration method to two sets of dynamic PET/CT data of two mice. The PET scan is a 1 hour FDG scan for breast cancer detection. The registration result is shown in the following figure where the PET and CT data is overlaped for each data set.

Conclusion

- Simultaneous acquisition of PET and CT scans using imaging chamber results in easily aligned anatomical and functional images.
- We have developed a novel volumetric warping scheme with surface and landmark constraints which registers mouse surface as well as interior anatomical details accurately.
- Application of our registration method could be useful for inter-subject comparisons of PET and CT data and improve the power of subsequent statistical tests.

References
