Purpose:

The aiming is to improve the mutual information based registration method for PET-CT scanner, which faces the challenges of high computational complexity and high likelihood of being trapped into local optima due to an absence of spatial information.

Methods:

In this work, new multi-scale registration framework called EPMR was proposed based upon an edge preserving total variation $L^1$ norm (TV-$L^1$) scale space representation. TV-$L^1$ scale space is constructed by selecting edges and contours of images according to their size rather than the intensity values of the image features. This ensures more meaningful spatial information with EPMR framework for MI based registration. Furthermore, we design an optimal estimation of the TV-$L^1$ parameter in EPMR framework by training and minimizing the transformation offset between the registered pairs for automated registration in medical system. We validated our EPMR method on multi-modal medical datasets from clinical studies with a combined PET/CT scanner. We compared our registration framework with other traditional registration approaches.

Results:

Our experimental results demonstrated that our method outperformed other methods in terms of the accuracy and robustness for medical images. EPMR can always achieve small offset value, which is more close to the ground truth, and the speed can be increased by 10%-14% comparing with other method for PET-CT registration under the same condition. Furthermore, clinical application by adaptive GTV (gross tumor volume) re-contouring for clinical PET/CT image guided radiation therapy throughout the course of radiotherapy is also studied, and the overlap between the automatically generated contours for CT image and the contours delineated by the oncologist using for the planning system are on an average 90%.

Conclusions:

In this work, we presented a novel scale space decomposition methodology to improve the traditional scale space decomposition and performance of Mutual information based image registration for PET-CT scanner.