AbstractID: 13860 Title: Unsupervised Nonlinear Dimensionality Reduction for Multiparametric Oncological Image Segmentation

Purpose: To investigate the use of unsupervised non-linear dimensionality reduction (NLDR) techniques for segmentation and quantification of multi-parametric breast MRI.

Methods and Materials: Five patients underwent breast MRI after suspicious findings on mammograms or clinical breast exams. All patients underwent either biopsy or mastectomy and histopathological analysis was performed. MR sequences were T1-weighted (T1WI:TR/TE=13/4.6ms), T2-weighted (T2WI:TR/TE=5700/102,FOV=18x18cm,256×192,ST=4mm), Dynamic Contrast-Enhanced (DCE:TR/TE=20/40, FOV=18x18cm,) after injection of GdDTPA contrast agent and Diffusion Weighted Imaging (DWI:TR/TE=5000/90ms,128x128,b=0,500, 750,1000s/mm^2). MR data was co-registered before application of the NDLR methods using a non-deformable model. NLDR methods used were Isomap, Fuzzy Isomap, Locally Linear Embedding (LLE) and Diffusion-Maps. The embedded image was constructed by projecting the feature spaces (image intensities) associated with each of the MR sequences into a one dimensional embedding space (manifold). The segmented regions were defined and lesion contours (LCs) were then detected by both embedded and DCE-MR. DCE-MR was selected for the ground truth for malignant breast lesions. Dice similarity (DS) indices were calculated and statistical analysis was performed on them.

Results: All patients had invasive ductal carcinoma. The segmented regions were congruent with a median DS of (Isomap:86.47%±17.6%), (Fuzzy Isomap:86.48%±15.3%), (Diffusion-Maps: 86.44%±15.9%) and (LEE:91.51%±4.3%). The computational load varied with the LLE as the having lowest compared to Isomap and Diffusion-Maps. Interesting, the LEE was able to efficiently segment breast normal and abnormal tissue using only T1/T2 and DCE. However by including DWI with multiple b-values, isomap showed better performance but with increased computationally costs.

Conclusion: There was high similarity between multi-parametric embedded and DCE-MR images using NLDR methods. Using unsupervised NDLR, we demonstrated an improvement in the accuracy of the lesion segmentation and performed better than a single parameter.