## AbstractID: 13716 Title: A neural network based registration quality evaluator for 2D-3D image registrations

Purpose: To construct a registration quality evaluator (RQE) for 2D-3D registrations that can automatically identify unsuccessful registration solutions. Method and Materials: Two orthogonal kV x-ray projections of an anthropomorphic cranial phantom were acquired with the Elekta Synergy system. The training dataset for the RQE construction was generated by registering the two x-ray images simultaneously to the CT image of the same phantom 300 times. The registration optimized the normalized mutual information (NMI) between the two radiographs and their corresponding digitally reconstructed radiographs that were computed from the CT dataset. For each registration repetition, a random initial alignment was used. The average voxel deviations within the region-ofinterest between the best known alignment and the registration solutions were computed. The registration solutions of the training dataset were categorized as "successful" and "unsuccessful" registrations by comparing the average voxel deviations with a user defined error threshold. For each registration solution, the symmetry and the distinctiveness that represent the local geometrical properties of the similarity measure function were computed. The supervised training was used to train a two-layer feed-forward neural network using above generated data. The network RQE was then used to evaluate registrations in a test data set. The confusion matrices and receiver operating characteristic (ROC) curves were used to evaluate the performance of the RQE. Results: RQE training yielded a sensitivity and a specificity of 0.944 and 0.971, respectively, for the training dataset. The sensitivity and the specificity were 0.955 and 1.00, respectively, for the test dataset. The ROC curves also confirmed the very good performance of the RQE. Conclusion: Our phantom study showed RQE had very good performance in identifying unacceptable results in 2D-3D registrations. As part of an automated patient positioning system, RQE can be combined with a 2D-3D registration algorithm to avoid local optima and improve robustness.