## AbstractID: 7643 Title: A 2D-3D Registration Quality Evaluator for Patient Positioning in Radiotherapy

**Purpose:** To construct a registration quality evaluator (RQE) for 2D-3D registration to automatically determine the "goodness" of a registration for user-defined error tolerance based on average pixel shift in the region of interest, a more consistent quantification of registration error, rather than conventional units in mm and degree.

**Method and Materials:** RQE was automatically constructed from two orthogonal kilovoltage portal images and their corresponding CT dataset of an anthropomorphic cranial phantom. Digitally reconstructed radiographs (DRRs) were generated from a registered CT dataset by adding known arbitrary displacements. Then normalized mutual information (NMI) values between each pair of DRRs and their corresponding portal images were computed, and associated with the known registration error. Based on a user-defined error tolerance, each sample, which includes a NMI value and its known registration error, was classified as a successful or unsuccessful registration. Finally, supervised learning was performed to calculate a decision threshold on NMI. To determine the goodness of a registration, the registration error can be estimated by calculating the NMI related to the registration output and comparing the value with the RQE threshold. To estimate RQE performance, radio-opaque markers were attached to the phantom and marker-based registrations were carried out independently to establish a gold standard. In the absence of markers, this standard can be established by using multiple runs of a registration algorithm alongside visual verification.

**Results:** RQE training yielded a sensitivity and a specificity of 0.9804 (0.8955-0.9995) and 0.9388 (0.8313-0.9872) respectively at 95% confidence interval. Using test dataset, the sensitivity and the specificity of RQE were 0.939 and 0.937, respectively.

**Conclusion:** Our phantom study showed RQE had very good performance in identifying registration errors 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.