Interactive 6-DOF 2D/3D Registration Using Transmission Imaging

This study assesses the accuracy of a new patient registration technique which is based on 2D X-ray images and runs at interactive speeds. Pose estimates in 6 degrees of freedom are recovered by comparing X-ray images with digitally reconstructed radiographs (DRRs). The DRRs are generated using a new data structure called a Transgraph, which is based on recent computer graphics results. The contents of the Transgraph are derived from pre-operative CT data, and the structure permits DRRs to be generated in a fraction of a second without further reference to the original CT volume. The synthesized DRRs reflect the full CT structure, including soft tissues, and permit the full field of view of the X-ray imager to be used in registration.

An anamorphic phantom head was fitted with an LED marker, which was placed outside of the field of view of a pair of X-ray imagers. This marker was tracked through approximately 450 poses using an active infrared optical tracking system having accuracy on the order of 0.1mm. Data from the optical tracking system were used to evaluate the new registration algorithm. RMS rotation errors of 0.554° , vs. 0.240° and 0.140° were observed in the transverse, sagital, and coronal planes respectively. RMS registration error over a 6cm x 6cm volume centered in the cranium was 0.802 mm.