AbstractID: 1843 Title: X-Ray Phantom for Simultaneous Calibration of Multiple Views

Reconstruction of three-dimensional features using fluoroscopic imaging demands accurate determination of the system's imaging geometry. There has been extensive work on the calibration and correction of distortion for a single, possibly mobile camera rig, but less attention has been paid to the robust calibration of multiple simultaneous imaging devices. We have created a calibration phantom and accompanying methods that extend the prior calibration literature to robust calibration of two or more simultaneous views, with a special emphasis on orthogonal biplane views. This phantom includes sixty-five spherical targets that are all visible, non-overlapping, and uniquely identifiable on orthogonal biplane views. The targets are easily segmented from the background and can be accurately localized. This arrangement allows the direct estimation of the intercamera transformation using a common coordinate frame and joint optimization of the cameras' imaging geometry. Distortion correction can be performed simultaneously without additional equipment. The phantom is constructed from materials that are compatible with x-ray, CT, MR, and ultrasound, so coordinate transformations can be established between modalities. Using this phantom, standard machine vision calibration techniques, and a joint optimization step, we have achieved a mean reconstruction error of 0.96mm across the working volume of a clinical biplane fluoroscopy system before distortion correction. Preliminary results indicate that distortion correction and multi-frame calibration may yield mean errors below 0.5mm. These results may be useful for improving the accuracy of real-time reconstruction and tracking applications in fluoroscopy, such as vessel reconstruction and intra-operative instrument tracking.

Supported by the National Institutes of Health.