

AbstractID: 3970 Title: A quick and accurate calibration method for 3D ultrasound in image-guided radiotherapy

**Purpose:** To develop a quick, accurate and user-independent method for calibrating a freehand 3D ultrasound system to CT-Sim and/or linac room coordinate systems.

**Method and Materials:** A 3D ultrasound system (Restitu, Resonant Medical Inc) designed to be used in both CT-Sim and radiotherapy treatment rooms is used. This system consists of a 2D ultrasound probe tracked by an optical tracker. An ultrasound phantom was developed which contains six embedded high-contrast rods at known locations. A removable top-plate was designed to hold the ultrasound probe in 7 slots with different positions/orientations relative to the rods. The user acquires one image per slot, thus obtaining 7 independent views of the 6 rods. The center of the rods are automatically detected in each ultrasound image. The algorithm calculates the optimal transformation between the detected and known rod positions. In this manner, the calibration from ultrasound image pixels to room laser coordinate system is determined. The transformation is appropriately scaled for different image depths. To evaluate the accuracy, a sphere embedded in the phantom was imaged and reconstructed into a 3D voxel image with the given calibration. The reconstructed center of the sphere was compared to its position derived from a CT scan of the same phantom .

**Results:** The ultrasound calibration procedure is found to be accurate to within the CT sphere center measurement uncertainty. System calibration requires less than 5 minutes.

**Conclusion:** The present calibration method enables a very quick and accurate method of converting a series of 2D ultrasound images into a 3D voxel set in CT-Sim and/or treatment room coordinate systems. This forms the basis for accurate 3D ultrasound imaging in radiotherapy, both for improved organ definition for planning and image guidance in the treatment room.

**Conflict of Interest:** The authors are employees of Resonant Medical Inc.