We have developed a technique that can determine the three-dimensional (3D) position and orientation of a distribution of points from a single projection image. The technique can be useful for calculating imaging geometries, re-aligning patients undergoing multiple radiation therapy treatments, and can now be extended to objects containing narrow point distributions, such as catheters.

A model of the object containing the distribution of points is generated based on the known, relative 3D point positions. After an initial positioning, the model is rotated and translated iteratively until the projections of the points in the model optimally align with their corresponding points in the image data. This iterative alignment process results in the 3D position and orientation of the object relative to the imaging system.

In simulation studies, the orientation and position were determined to within approximately 0.4 degrees and 0.1 cm, respectively, for points distributed within a 5 x 5 x 5 cm^3 volume and to within approximately 3 degrees and 0.2 cm, respectively, for points distributed in a volume as thin as 5 x 5 x 0.1 cm^3. In additional simulation studies, the orientation and position of points distributed along a catheter of diameter of 0.183 cm were determined to within 3 degrees and 0.5 cm.

We believe this technique will facilitate the analysis of the 3D position and orientation of objects, even objects as thin as 1 mm, such as catheters during interventional procedures.

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