Source and Detector Transformation matrices in TREK FluoroSimulator module.

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1. Source Transform

The purpose of source transform is to define source position in world coordinate. The transform is composed of three components: orientation, orbital rotation, and angular rotation. Therefore, the transformation could be defined as:

$$T_S = OR_a(\alpha)R_o(\omega)$$

where O represents an orientation, R_o represents orbital rotation, and R_a represents angular rotation. Under an assumption that original source position lies on an x-axis, R_o rotates the source about y-axis for an angle ω, and R_a rotates the position about an axis z', which is a rotated z-axis, for an angle α. Figure 1 describes a view in a direction of a y-axis. In figure 2, axis z' is defined as a line passing origin and a point (x,y,z) = (sin ω,0,cos ω), where ω is an orbital position of C-arm.

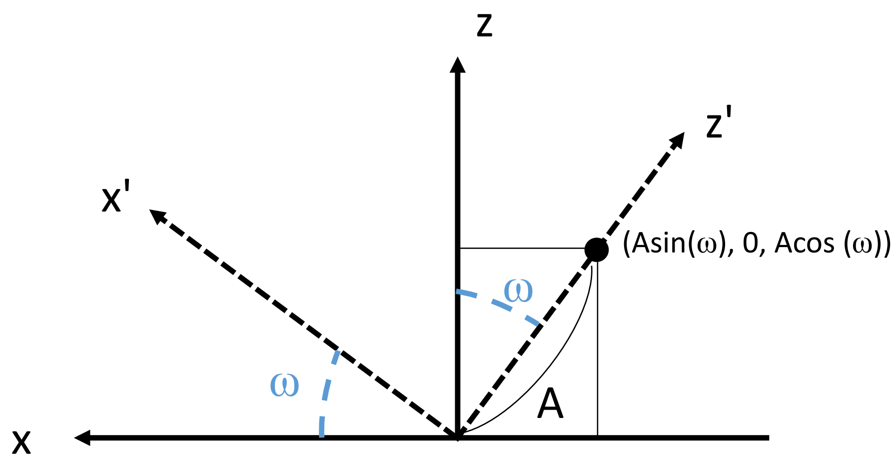

Figure 1. Schematic for a rotated z-axis

R_a and R_o are therefore rotation matrix with angle α and ω about the axis (0,1,0) and (sin ω,0,cos ω). These rotations, however, are valid only if the original source position lies on the x-z plane. To compensate this, there is an orientation matrix O that rotates these transformations to align the transformation with respect to a plane with zero angular position.

2. Detector Transformation

Detector transformation is similar to the source transformation. On an X-ray C-arm, detector and source has a fixed source-to-detector distance (SDD) and positioned at the opposite side. Therefore, the detector transformation rotates could be described as a source transformation with additional π/2 rotation in either angular or orbital direction. On our system, additional π/2 is added in angular position to define the source position. Therefore, source transform TD is:

$$T_D = OR_a\left(\alpha + \frac{\pi}{2}\right)R_o(\omega)$$