

## ON THE USE OF ROBOTICS FORMALISM IN THE DESCRIPTION AND MODELING OF ANTENNA RANGE POSITIONERS

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*Fixed in measurement*

A typical positioner used for positioning an antenna under test on an antenna range has two or three rotation axes arranged in such a manner as to facilitate the taking of data along certain paths through the antenna pattern (pattern cuts). It will usually have one horizontal rotation axis (the elevation axis), a vertical axis (the azimuth axis), and possibly an additional axis sometimes called the roll axis which is oriented by the other two. In the most straightforward of measurement sequences, all but one of the axes are fixed and the desired axis is rotated over a prescribed range of angles during which data samples of the received signal are taken. The transmit antenna illuminates the antenna under test from a location in the far zone resulting in a plane wave at the positioner. As measurement sequences become more complex, perhaps requiring simultaneous motion of several axes, two needs arise. First, given the desired angular trajectory, one must determine the necessary axis rotations to achieve it. Second, if phase data is to be properly interpreted, one must obtain, for the particular trajectory used, the transmitting antenna / receiving antenna distance for each data sample. These needs can be conveniently met by means of the existing formalism developed for description and control of the behavior of industrial robots. [See, for example, J. J. Craig, Introduction to Robotics, Addison-Wesley, Reading, MA, 1986]

To properly describe the behavior of a given positioner, one must first identify the parameters of the positioner model. We have done this by performing a set of diagnostic phase measurements which effectively measure the transmitting antenna / receiving antenna distance and optimizing the fit between these data and corresponding data generated by a simulated positioner. The fit is optimized by adjusting the geometrical parameters in the positioner model such as the angles between the various rotation axes. Once this parameter identification has been successfully accomplished, the positioner model can be used to prescribe the necessary axis rotations to achieve a desired trajectory and to determine the transmitter / receiver distance for each data point. In fact, even if the positioner is damaged or improperly constructed so as to render, for example, the angle between two ostensibly orthogonal axes significantly different from ninety degrees, robotic modeling can be used to determine the rotations necessary to compensate for the positioner shortcomings and achieve the desired trajectory. In this paper we describe our experiences with this application of robotics.



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