Development of a Pattern Simulator for Benchmarking a Near-field Holographic Image Processor

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Abstract

Deformations of the reflector optics comprising a radio telescope can introduce station position errors that are significant in the context of VLBI2010. Radio holographic imaging is a technique that can be utilized to detect such deformations. In experiments involving large reflector antennas at relatively high frequencies, geosynchronous satellites are observed to conduct the radio holography since the stand-off ranges satisfy the far-field requirement. However, these sources are relatively fixed with respect to the radio telescope, and this limitation does not facilitate the ability to track and correct the deformations over the telescope’s full field-of-view. This near-field holographic imaging technique overcomes this limitation of the satellite-based far-field technique since the source is under the control of the observer and may be placed in close proximity to the radio telescope. In question. Additional complexities arise in this near-field scenario but those considerations have been addressed in the literature. In this report, a near-field pattern simulator was developed to facilitate testing of a near-field holographic image processor. The results of this simulator have been compared against independent expectations to validate the simulator.

Test Cases

In this project, MATLAB code was developed and tested to simulate the complex near-field receiving pattern of an idealized antenna aperture for the purpose of benchmarking a near-field holographic image processor. This software allows the operator to define the antenna aperture as an array of variable height apertures, isotropic receiving elements as well as the span of the beam scan parameters. Through this aperture is rotated to observe the complex receiving pattern, once this software was developed and gave seemingly accurate results, the results needed to be verified. Test cases 1 and 2 helped to do that by qualitatively and quantitatively checking the complex receiving pattern and that the calculation of r the code was calculating were correct for each angle they were being computed against.

Applications

Antenna structures undergo both thermal and gravitational deformations. Both bias the effective position of the antenna. The development of a stable, externally accessible test reference marks is necessary for decoupling geophysically insensitive site time-delays from intrinsic antenna deformations, for enabling comparisons and combinations of VLBI with other techniques, and for providing more general access to the VLBI frame.

Conclusion & Future Works

The test cases proved that the complex aperture simulator is working correctly. Since the impetus for this project is the development of a near-field holographic image processor, the next logical step is to develop such a software utility. The software developed in this project would serve as a benchmark radiation pattern for such a processor. Given the confidence in the accuracy of the results that were reported regarding the complex receiver pattern simulator, this software tool may be used to establish the integrity of the imagery generated by the near-field image processor during software development.

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Sources