Guidelines for Student Reports

Synthesis Of Radio-Astronomy Arrays Based On Adss And Genetic Optimizers

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Abstract

Radio astronomy is the observation of celestial bodies by measuring their emission of radio waves. Because of the much larger wavelength than visible light, and as a consequence of the very low power of celestial sources, this observation is based on the use of large antennas (paraboloids of tens of meters in diameter) combined to form an array (sometimes several hundred miles of aperture). In order to increase the effective size of the array and to make the acquisition of celestial images faster, these systems are based on the analysis of the correlation between the received signals. To maximize the performance of the array of antennas by reducing redundancy, the cost and complexity, the design of arrays for radio astronomy is based on the selection of the optimal positions of the radiating elements. In this context, the ELEDIA group has developed analytical design methodologies based on Almost Difference Sets which can guarantee a-priori performances in terms of redundancy and radiating characteristics of the resulting array design and an extremely reduced design time even in the case of large arrays. However, the main limitation of these methodologies is related to the fact that they provide only sub-optimal performance, which consequently require a refinement in the process of design. Moreover, ADSs do not allow the choice of arbitrary geometries, thus constraining the design to certain configurations.

One possible solution to these limitations is the use of global optimization tools, such as Genetic Algorithms, in conjunction with the ADSs in order to improve the performance of ADS-based arrays in a few iterations (thus avoiding the typical problems of global optimization algorithms when problems to deal with have very high search spaces). The purpose of the activity is therefore to develop and analyze a design methodology for arrays for radio astronomy based hybrid GA, which includes the use of ADSs in the case of planar geometry and to evaluate advantages and limitations in terms of Peak Sidelobe Level, coverage of baselines, and spatial resolution.

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