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Opportunity Title: Fractile Phased Array Antennas
Opportunity Reference Code: ICPD-2021-33

Organization Office of the Director of National Intelligence (ODNI)

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Complete your application – Enter the rest of the information required for the IC Postdoc Program Research Opportunity. The application itself contains detailed instructions for each one of these components: availability, citizenship, transcripts, dissertation abstract, publication and presentation plan, and information about your Research Advisor co-applicant.

Additional information about the IC Postdoctoral Research Fellowship Program is available on the program website located at: https://orise.orau.gov/icpostdoc/index.html.

If you have questions, send an email to ICPostdoc@orau.org. Please include the reference code for this opportunity in your email.

Application Deadline 2/26/2021 6:00:00 PM Eastern Time Zone

Description **Research Topic Description, including Problem Statement:**

The application of fractal geometry principles to the design of individual antennas and phased array antenna systems creates fractal antennas. Fractal antenna engineering can offer many techniques to optimize both antenna elements and phased array designs. For example, individual antenna geometries can be optimized to create fractal radiation patterns, to operate in multiple frequency bands, to minimize sensitivity to loads, to miniaturize lower frequency antennas (UHF/VHF), and to design frequency selective surfaces (FSSs).Due to their self-similar structure, fractal antennas also can provide broadband operation.

For phased array systems, designs based on a fractal lattice geometry—known as fractile phased arrays—can offer performance similar to that of a traditional phased array lattice design, such as rectangular or hexagonal, but with a reduced element count for optimized designs. Such a capability proves extremely beneficial for the systems engineer since it would reduce cost, complexity, and development time for a specific phased array system acquisition.

The approach is to conduct a study on various phased array designs based on fractal lattice structures to compare their performance against traditional phased arrays using both the mathematical array factor and the combined array antenna pattern, including a notional element pattern. The study would also include models and simulations on the performance comparisons for both broadside and beam steering operations to gauge scan loss and other performance metrics.

Example Approaches:

Much work has been presented in the literature for optimizing fractile phased arrays using genetic algorithms, particle swarm, and other techniques using peak side lobe level (SLL) as the fitness function. From a system engineering perspective, a more optimal fitness function may be the integrated side lobe ratio (ISLR), which is a ratio of the total integrated power in the side lobes to the total integrated power in the main beam. Minimizing ISLR may provide a higher signal-to-noise ratio (SNR) from the antenna. There is little to no work reported in the literature using this fitness function. An effort to optimize a fractile array design using both peak SLL and ISLR to compare outcomes would provide valuable design insight for future phased array systems.

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A comprehensive understanding of the percentage of array antenna elements that could be reduced based on fractile phased arrays is needed. Because phased arrays are complex and costly to manufacture, reductions in element count can save a large amount of development and production time, thereby reducing costs.

A full understanding of beam steering and amplitude tapering for fractile phased arrays (optimized or not) is also needed.

Relevance to the Intelligence Community:

To understand how aperiodic phased array lattice designs could inform future phased array system designs for remote sensing systems.

Key Words: Fractals, Fractile, Phased Arrays, Array Antennas

Qualifications

Postdoc Eligibility

- U.S. citizens only
- Ph.D. in a relevant field must be completed before beginning the appointment and within five years of the application deadline
- Proposal must be associated with an accredited U.S. university, college, or U.S. government laboratory
- Eligible candidates may only receive one award from the IC Postdoctoral Research Fellowship Program

Research Advisor Eligibility

- Must be an employee of an accredited U.S. university, college or U.S. government laboratory
- Are not required to be U.S. citizens

Eligibility Requirements

- **Citizenship:** U.S. Citizen Only
- **Degree:** Doctoral Degree.
- **Discipline(s):**
  - **Chemistry and Materials Sciences** (12)
  - **Communications and Graphics Design** (2)
  - **Computer, Information, and Data Sciences** (17)
  - **Earth and Geosciences** (21)
  - **Engineering** (27)
  - **Environmental and Marine Sciences** (14)
  - **Life Health and Medical Sciences** (45)
  - **Mathematics and Statistics** (10)
  - **Other Non-Science & Engineering** (2)
  - **Physics** (16)
  - **Science & Engineering-related** (1)
  - **Social and Behavioral Sciences** (27)