Continuous Real-Time Circuit Reconfiguration to Optimize Average Performance for Spectrum-Sharing Radar Transmitters

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As the available wireless spectrum has become more congested, fixed spectrum assignments are subject to spectrum sharing, including recent expansion in the United States S-band radar re-allocation. In a spectrum sharing environment, radar transmitters must be able to adapt their hardware to obtain acceptable performance over a wide selection of operating bands, rather than utilize a static configuration optimized for a single band.

Existing real-time circuit optimization techniques have demonstrated the ability to tune and optimize the circuit configuration (amplifier load impedance, input power, bias voltages, etc.) for an otherwise static system. In these approaches, the system's current configuration is dictated by the optimization algorithm alone, and configuration changes are made in a controlled manner that provide information about the impact of each system parameter. However, adaptive systems that rapidly, continuously, and independently alter the system configuration in response to external stimuli (such as a radar modifying its transmit waveform in response to the presence of interfering devices) diminshes the algorithm's ability to perform an effective search. While typically used approaches essentially run multiple optimizations in parallel for each adapted configuration and pursue a weighted combination of the actions recommended for each individual configuration, the relative performance of each configuration must be considered if the goal is to find a result that maximizes average performance.

This work improves upon the state-of-the-art with a continuously running gradient-based search algorithm adapting the transmitter amplifier load impedance of a cognitive, software-defined radar system to maximize its average output power. The average power is determined over a range of measurements as the congitive radar independently alters its operating frequency and bandwidth in response to interference. While past approaches have utilized a fixed measurement window, the optimal window is dependent upon the complexity and frequency of the adaptive system's responses and may change over time. This work introduces an adaptive measurement window that is adjusted during optimization to minimize the rate of convergence, while also ensuring the end result accurately reflects the optimum solution for the system's current behavior. We show excellent performance results during spectrum-sharing, frequency agile scenarios where the operating frequency changes quickly when our novel algorithm is utilized.