A Simultaneous Circuit and Waveform Optimization for Radar Systems

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As the number of wireless broadband devices occupying our airwaves grows at a rapid rate, the resultant shrinking of available spectrum for current technologies and increasingly stringent regulations on band compliance has necessitated adaptive RF technologies which can respond to the spectrum crisis. This presentation presents an architecture which combines a waveform synthesis (Eustice *et al.*, "Optimizing Radar Waveforms Using Generalized Alternating Projections," Texas Symposium, 2015) and circuit optimization technique (Baylis *et al.*, "Enabling the Internet of Things: Reconfigurable power amplifier techniques using intelligent algorithms and the Smith tube," Circuits and Systems Conference, 2014) previously designed by the Wireless and Microwave Circuits and Systems program from Baylor University.

The waveform synthesis algorithm uses alternating projections to iteratively create waveforms which are optimized for desired ambiguity function properties with constraints on the waveform's peak-to-average-power ratio and spectrum. The circuit optimization technique optimizes the power added efficiency of the circuit under constraints on the adjacent channel power ratio using a gradient descent method to vary circuit parameters such as load impedance, input power, and DC bias.

The architecture combining the two methods does the computations required for each in parallel, while using a decision tree based on ambiguity function quality and signal matching to periodically update the waveform being used in the circuit optimization process. The result is a real time, waveform-in-the-loop optimization which both creates a waveform with desirable ambiguity function, peak-to-average-power ratio, and spectrum properties and finds circuit parameters which maximize the power added efficiency while constraining the amount of spectral spreading due to amplifier non-linearities.

The effectiveness of this method is evaluated by comparing measurement results using waveform-in-the-loop joint optimization to those obtained after running the two optimizations seperately. We see higher peak-to-average-power ratios and lower adjacent channel power ratios using the joint waveform-in-the-loop optimization when compared to preformance of the system after running the optimizations successively.