Artificial Neural Network Power Amplifier Input Signal Synthesis for Radar Joint Circuit and Waveform Optimization

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Radar transmitters contain nonlinear power amplifiers that distort the input waveform. The undesirable effects of this distortion cause less effective Range/Doppler resolution characteristics as well as unwanted spectral spreading. This also causes significant difficulties in the joint circuit and waveform optimization of a power amplifier to provide a desired output waveform ambiguity function while optimizing the power efficiency and meeting spectral mask constraints. A real-time modeling approach for the power amplifier can allow an input waveform to be created that will generate an output waveform with the desired ambiguity and spectral constraints. This presentation demonstrates a feed forward artificial neural network (ANN) technique for input synthesis of a power amplifier input waveform during real-time optimization. The ANN is trained during device operation to supply a power amplifier input waveform that produces a more desirable output waveform. This technique described as input signal synthesis differs from traditional power amplifier predistortion. In power amplifier predistortion techniques for communications, the objective is to linearize the power amplifier. In signal synthesis for this radar application, the ANN is trained in the feed forward mode after which the ANN is inverted with constraints to synthesize an appropriate amplifier input.

In the case of joint circuit and waveform optimization, the desired output waveform is calculated during the optimization. In the real-time optimization, each measured power amplifier output waveform is supplied to an alternating projections block to produce a more desired waveform based on the peak-to-average power ratio (PAPR), ambiguity function, and spectral mask constraints. The desired waveform from this alternating projections block is input to the ANN as the target waveform for training. The output waveform directly measured from the power amplifier is also input to the ANN. The output waveform of the ANN is then fed back to the power amplifier and the loop continues based on a user-specified number of iterations.

The ANN, when inverted, is input to the power amplifier such that the error is reduced between the computed target waveform from the alternating projections block and the output waveform from the power amplifier. Once the ANN weights have been determined through backpropagation, the ANN is successfully trained and inversion can be applied in which the weights and target waveform are now fixed. The ANN then uses its fixed weights to minimize the error between its output and the single fixed target waveform to find an input to be supplied to the power amplifier that will approximately give the target waveform as its output.

Using an ANN to synthesize the radar power amplifier input waveform will provide better adaptability to a changing environment in joint circuit and waveform optimizations for adaptive and reconfigurable radar transmission.