Cognitive RF Processing for Nonlinear Radar

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An increasingly cluttered electromagnetic (EM) environment is a growing problem for radar and RF systems. This problem is becoming critical as the available frequency spectrum shrinks due to growing wireless communication device usage and changing regulations. A possible solution to this problem is cognitive RF processing, where the cognitive RF system learns from the environment and intelligently modifies the transmit waveform. In this paper a proposed cognitive RF processing framework is discussed for nonlinear radar. Nonlinear radar produces frequencies in a nonlinear target (e.g. electronics or metal object) that are different from those transmitted by the radar thereby separating natural clutter from the nonlinear target response. An example of nonlinear system applications include automobile accidence avoidance, junction range finder, detection of concealed weapons, electronics, and other man-made objects, electronic device detection for FCC Part-15 compliance, insect tracking. The proposed processing framework, i.e. the nonlinear cognitive radar (NCR) framework, utilizes a target detection methodology applied to nonlinear radar. This methodology has the advantage, as compared with other nonlinear radar systems that do not implement a cognitive scheme, to adapt to the radio frequency (RF) environment by intelligently selecting waveform parameters using adaptive algorithms. The adaptive algorithms optimize the waveform parameters based on: 1) the EM interference, 2) target likelihood, 3) permissible transmit frequencies as specified by regulations and allowable by other systems operations within the environment.

The proposed NCR processing system is illustrated in Figure 1. Multiple receivers are used and grouped into two categories: 1) an array of passive spectrum receivers, and 2) the radar receiver. The passive spectrum receivers sense the RF environment to detect EM interference. Multiple passive receivers are implemented to measure multiple bands/channels of interest simultaneously. Multiple receivers have the advantage, as compared with a single passive receiver, to reduce the time needed to measure multiple frequency bands of interest. Spectrum sensing techniques process the passive measurements for noise, interference, and signals operating in the environment so that the radar transmitter and receiver operate in bands outside these preexisting signals. After an appropriate waveform has been chosen for target detection, the radar receiver measures the RF environment in response to the transmit waveform. Potential target information, or features, are extracted from the radar receive signal. The signal to noise ratio (SNR) is estimated and processed by target detection and classification algorithms. The parameters for a new transmit waveform (i.e. amplitude, frequency, phase, modulation, etc) are optimized based on target detection likelihood, noise and interference power levels, and permissible transmit frequencies (as specified by the database). Parameters are selected and the waveform is transmitted. This process reiterates until the presence or absence of a target is determined with high confidence.

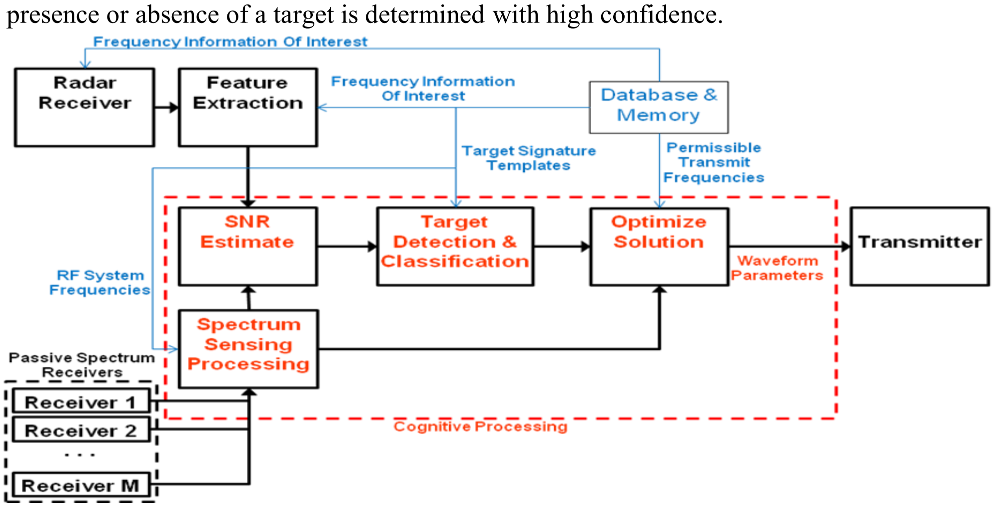

Figure 1: Proposed Nonlinear Cognitive Radar Processing Block Diagram.