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Generalized self-tuning system for adaptive threshold estimators in cognitive radio systems using swarm and evolutionary-based approaches

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Abstract

Parameter-based adaptive threshold estimators (ATEs) are widely used for signal detection in cognitive radio (CR) systems. However, their performance deteriorates under dynamic spectra conditions owing to a lack of valid methods to accurately self-tune the different parameters of such ATEs. In this article, we address this limitation by proposing a generalized system for self-tuning the parameters of any ATE based only on the input signal measured per time. We adopt swarm and evolutionary-based metaheuristic optimization techniques to effectively search for the optimal parameter values of any ATE. Our system controls the search process by applying the between-class variance function adapted from Otsu's algorithm as the objective function. We tested the system using five different metaheuristic optimization algorithms (MOAs) to self-tune two different ATEs, namely the recursive one-sided hypothesis testing (ROHT) technique and the histogram partitioning algorithm under Rayleigh and Rician fading channels, as well as under different modulation schemes, including the 4-quadrature amplitude modulation and 4-phase shift keying schemes. Our findings suggest that our proposed system yields generally a small error rate irrespective of the MOA used. In addition, the ROHT-cuckoo search optimization configuration yielded a reasonably high and low probability of detection and probability of false alarm, respectively, as a function of the signal-to-noise-ratio of the input signal at a fast average processing time of 0.0699 seconds. We concluded that our system presents an effective mechanism that can be used to automatically tune the parameters of any ATE for useful signal detection in CR.