Learning-Based Distributed Detection-Estimation in Sensor Networks with Unknown Sensor Defects

Abstract:

The problem of distributed estimation of an unknown deterministic scalar parameter (the target signal) in a wireless sensor network (WSN) is considered, where each sensor receives a single snapshot of the field. It is assumed that the observation at each node randomly falls into one of two modes: a valid or an invalid observation mode. Specifically, mode one corresponds to the desired signal plus noise observation mode (valid), and mode two corresponds to the pure noise mode (invalid) due to node defect or damage.With no prior information on such local sensing modes, a learning-based distributed procedure is introduced, called the mixed detection-estimation (MDE) algorithm, based on iterative closed-loop interactions between mode learning (detection) and target estimation. The online learning step re-assesses the validity of the local observations at each iteration, thus refining the ongoing estimation update process. The convergence of the MDE algorithm is established analytically. Asymptotic analysis shows that, in the high signal-tonoise ratio (SNR) regime, the MDE estimation error converges to that of an ideal (centralized) estimator with perfect information about the node sensing modes.