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Bayesian Distributed Detection by Sensor Networks with Missing Data

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Abstract

We consider detection and identification of a moving target, using a network of sensors. The target emits a signal; a stationary stochastic process corrupted by additive noise, independently across sensors. Before inter-sensor communication, all sensors reduce external data as energy over disjoint frequency bands and time blocks. One sensor, the internal fusion center (IFC), gathers feature vectors from the other sensors, possibly after message passing. Using Bayesian decision theory, it decides for presence or absence of the target and computes a maximum posterior estimate of target (trajectory and spectral) parameters. The main novelties of the paper are: 1) To apply statistical theory of missing data to an inter-sensor communication protocol which censors weak signals before transmission and an imperfect channel in which some transmitted signals are lost. A Naive Bayes approximate detector is defined, which requires recursive computation of reception probabilities. 2) To derive asymptotic approximations of the distribution of the spectral feature vectors and a Laplace type approximation of the detector. The performance of the proposed Bayesian detector is shown in a simulation study to be only slightly inferior to that of an ideal Bayesian detector (with no missing data), as well as superior to a naive detector.

Key words: Bayesian detection, data reduction, distributed detection, internal fusion center, missing data, routing, periodogram, sensor network.

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