

Asymptotic Locally Optimal Detector for a Large Sensor Network under the Poisson Regime

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Abstract

We consider the distributed detection problem with a large number of identical sensors deployed over a space where the phenomenon of interest has different signal strength depending on location. Each sensor makes a decision based on its own measurement of the spatially varying signal and the local decision of each sensor is sent to a fusion center through a multiple access channel. The fusion center decides whether the phenomenon of interest occurred or not with some size constraint under Neyman-Pearson context.

Assuming that the initial distribution of sensors is a homogeneous spatial Poisson process, we showed that the distribution of alarmed sensors satisfies the locally asymptotic normality (LAN) condition as the number of sensor increases and derived a new asymptotically locally optimal criterion for the detection of the spatially varying signal. We showed that an optimal test statistic is a weighted sum of local decisions and an optimal weight is the shape of the spatial signal of interest and the exact value of the spatial signal is not required.

It is shown that the spatial signal is translated to the local intensity of alarmed sensors with Poisson assumption and the optimal weight is easily estimated based on the number of alarmed sensors and their locations. For the case of independent, identical distributed (iid) sensor observation, we showed that the counting rule is also asymptotic locally optimal.

Index Terms - Distributed detection, Spatially-varying signal, Poisson distribution, Locally asymptotically normal (LAN), Asymptotically locally optimal, Neyman-Pearson criterion.