SENSOR NETWORK NODE SCHEDULING FOR ESTIMATION OF A CONTINUOUS FIELD

E. Björnemo, M. Johansson, D. Aronsson
Signals and Systems Group, Uppsala University, Sweden
eb,mj,dar@signal.uu.se

Abstract

A wireless sensor network consists of radio-equipped sensors that are spread out in space to perform some network task, such as monitoring or estimating a field quantity. In many sensor networks, the main limitation is the scarce energy resources available at each sensor node. A major issue is therefore optimisation of the activity in the network with respect to energy consumption. We investigate such an energy-limited sensor network, whose purpose is to estimate a continuous field over a certain spatial and temporal range. One way of reducing energy consumption is to utilise knowledge of the field variations to reduce the number of actual measurements and thus not waste energy on measuring quantities that can be inferred with knowledge of related parameters.

We investigate the trade-off between estimation performance and resource cost in terms of energy consumption, and devise a general Bayesian estimation scheme to take advantage of (necessarily incomplete) knowledge of physical properties of the field, such as bounds on time and space variations. Each measurement is taken at a discrete point in space and time and our goal is to infer the entire field over a given time and space horizon. We assume that the position of each node is known and that there is a known node-specific cost associated with each sensor measurement. The central unit schedules sensor measurements according to cost and information gain. We assume simple sensors that only perform the assigned measurements and forward them to the central unit along pre-defined routeS.

We illustrate how different states of uncertainty lead to interesting special cases of the general problem scenario, and discuss relations to Nyquist sampling of a time series of known bandwidth.