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Optimal Power Allocation for Outage Probability Minimization in Fading Channels with Energy Harvesting Constraints

Abstract:

This paper studies the optimal power allocation for outage probability minimization in point-to-point fading channels with the energy-harvesting constraints and channel distribution information (CDI) at the transmitter. Both the cases with non-causal and causal energy state information (ESI) are considered, which correspond to the energy-harvesting (EH) rates being known and unknown prior to the transmissions, respectively. For the non-causal ESI case, the average outage probability minimization problem over a finite horizon of N EH periods is shown to be non-convex for a large class of practical fading channels. However, the globally optimal "offline" power allocation is obtained by a forward search algorithm with at most N one-dimensional searches, and the optimal power profile is shown to be non-decreasing over time and have an interesting "save-then-transmit" structure. In particular, for the special case of N=1, our result revisits the classic outage capacity for fading channels with uniform power allocation. Moreover, for the case with causal ESI, we propose both the optimal and suboptimal "online" power allocation algorithms, by applying the technique of dynamic programming and exploring the structure of optimal offline solutions, respectively.