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Author: Dr. Yingnan ZHANG
China Academy of Space Technology (CAST), China

Mr. Danian LOU
China
Mr. Wei WANG
China

INTERVAL SPLITTING APPROACH TO THE OPTIMAL POWER CONTROL OF SATELLITE DIVERSITY SYSTEM

Abstract

This paper provides an analytical treatment to the power control problem of satellite diversity networks. In the system model, a pair of terrestrial terminals communicate with each other via several satellite repeaters, and a data packet is transmitted from the source terminal to the destination terminal using 2 time slots. In the first slot, the source sends signal to all of the satellite repeaters and the destination keeps silent. In the second slot, the satellite repeaters first coherently scale their respective received signals with corresponding power scaling factors, then they simultaneously transmit the scaled versions to the destination. After two time slots, the destination receives a linear combination of the signals from all of the satellite repeaters, and processes it (demodulate and decode) to recover the original information from the source. The distance between any of the two satellite repeaters is far enough, therefore a diversity gain could be achieved because the received signals at different satellite repeaters experience independent fading channels. The satellite repeaters are assumed to be transparent and adopt circuit switch.

In the power control problem, the optimization target is to maximize the signal-to-noise-ratio (SNR) of the received signal at the destination, under which each satellite repeater has an individual transmission power constraint, moreover, they are assumed to have an aggregate power constraint. The problem formulation corresponds to the "Coherent AF" case of T. Quek et al's prior work [1].

Unlike the numerical treatment in [1], in this paper an analytical approach is proposed to solve the power control problem completely. Firstly, the structure of the optimal solution is provided by using the Lagrange multipliers method. Then, based on the Karush-Kuhn-Tucker (KKT) conditions, an interval splitting approach is proposed so that the size of the candidate set for the optimal solution is considerably reduced from $O(2^K)$ to $O(K^3)$, in which K denotes the number of satellite repeaters. According to the proposed structure, the optimal solution could be finally determined from the reduced candidate set. That is, using the proposed method, the complexity to solve the power control problem is reduced from exponential to polynomial order. Since the power control problems studied in [2] and in Sec. III of [3] could be regarded as special cases of our model, we further illustrate how the proposed approach fits into the results in [2] and [3], respectively. Simulation results confirm the validity of our theoretical analysis.