EXACT BER ANALYSIS FOR PHYSICAL LAYER NETWORK CODED RELAY CHANNELS

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Abstract

Physical-layer network coding (PNC), a subfield of network coding is one of the techniques used in wireless two-way relay channel (TWRC) communication to achieve a higher spectral efficiency. Recently, with the cooperative communication initiative in 5th generation cellular communication, the viability of PNC as a method of enhancing spectral efficiency has been a popular research topic. In PNC, two end nodes transmit to a common relay simultaneously and the relay detects the XORed value of the transmitted bit combination. The XOR bit is then broadcasted back to the nodes, by which each of the end nodes calculates the other node's information bit using a second XOR operation. Compared to conventional relay communication, which uses four time-slots to complete single transmission cycle, PNC coded relay systems only use two time-slots. Thus, PNC doubles the throughput of a TWRC communication system.

Multiple TWRC systems, operating parallelly had also attracted high recent research interest as this topology is presented in many practical networks. Bit error rate (BER) performance of PNC coded relay systems have been widely explored using Monte-Carlo simulations and there had been several recent attempts to derive the theoretical BER expressions for PNC coded relay systems. The exact BER expressions have been derived for PNC coded systems having additive white Gaussian noise channels as well as Rayleigh fading channels. Moreover, these derivations have been extended to systems which employs multiple parallel TWRC. In this research, we focus on deriving the closed form BER expressions for systems consisting of multiple parallel TWRC communications over Rician faded channels. First we consider each constellation point under PNC mapping and determine the conditional error probability under maximum likelihood detection rule, given that a signal combination corresponding to the considered constellation point was transmitted. Then the conditional error probabilities are used in the calculation of the overall BER expression. The derived analytical expression has been validated by the Monte-Carlo simulations and is shown to be well matching with the simulation results.

Keywords: Bit error rate, Physical layer network coding, Two-way relay channel