

Abstract

With the rapid evolution of wireless communication technologies, the demand for higher data rates and improved quality of service continues to grow, emphasizing the need for increased spectral and energy efficiency. Researchers are actively exploring novel wireless technologies and assessing their performance to meet the requirements of next-generation wireless systems. Intelligent reflecting surfaces (IRS) are recognized as a promising technology capable of augmenting the spectral and energy efficiencies of wireless networks through a cost-effective solution. Therefore, there is considerable interest and demand for the analysis and evaluation of IRS-aided wireless system performance in the context of next-generation networks.

The outage probability (OP) performance of multiple-IRS-assisted single-input-single-output (SISO) wireless communication systems over Rician fading channels, focusing on IRS panel selection is analyzed. Using the central limit theorem (CLT) and Laguerre series expansion (LSE), approximate closed-form expressions for OP are derived. Additionally, a straightforward asymptotic OP is derived to determine diversity order and coding gain. Each system parameter's impact on OP performance is thoroughly examined.

Next, the OP analysis of multiple IRS-assisted SISO systems with switched diversity schemes is presented. OP expressions for the dual-IRS-panel-aided switch and stay combining (SSC) system and multiple-IRS-panel-aided switch and examine combining (SEC) system are analyzed over Rician fading channels. Tight approximate OP expressions in closed form are derived for a large number of IRS elements, along with

a simple asymptotic OP to study diversity order and coding gain. Numerical OP results are provided, accompanied by simulated OP results to validate the accuracy of the analytical analysis.

Further, multiple IRS within a wireless system contribute to enhanced performance, efficiency, and flexibility in wireless networks. The OP for wireless systems aided by multiple IRS panels operating over Nakagami- m fading channels is analyzed. Two closed-form expressions for OP utilizing the CLT and LSE are derived. Moreover, a novel asymptotic OP expression is developed, leading to the discovery of a unique diversity order. The diversity order of the system model in question is contingent on the minimum fading parameter (m) existing between the transmitter-IRS panel and IRS panel-receiver links, alongside the count of IRS panels. A thorough investigation into the impact of system parameters is conducted, and the validity of our analytical findings is confirmed through comprehensive simulations. The results demonstrate the significance of the diversity order, which is closely tied to the minimum fading parameter (m) between the transmitter-IRS panel and IRS panel-receiver links, the number of elements within each IRS panel, and the total number of IRS panels.

Next, bit error rate (BER) performance of an IRS-assisted downlink power domain non-orthogonal multiple access (NOMA) system is analyzed by considering successive interference cancellation (SIC) errors. In this setup, direct links between the base station (BS) and users are obstructed by deep shadowing in IRS-NOMA. The IRS-assisted NOMA system is assumed to experience independent and non-identically distributed (i.n.i.d.) Rician fading channels. Closed-form BER expressions for each user in the IRS-assisted NOMA system are derived. The study investigates the impact of varying IRS element count, IRS-to-BS distance, Rician factor, and power coefficient fluctuations of users on BER performance, validated through simulations.

Lastly, an IRS-assisted ultra-wideband (UWB) communication system, referred to as IUWB, is studied to enhance energy efficiency. To address the limitations of coherent

phase shift schemes at IRS, a novel strongest-path-based phase optimization method is proposed, leveraging time-resolved UWB multipath characteristics. Analysis encompasses the evaluation of BER and sum-rate performance of IUWB, comparing it against a standard UWB system without IRS. Impact of various parameters including the number of reflecting elements, diverse UWB channel models, and IRS positioning on the performance of IUWB is considered. Simulation outcomes highlight the advantageous attributes of IUWB, particularly in terms of energy efficiency and sum-rate.

